CARIBOU HERD DELIMITATION AND SEASONAL MOVEMENTS BASED ON SATELLITE TELEMETRY ON VICTORIA ISLAND 1987-89.

Northwest Territories Resources, Wildlife & Economic Development

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CARIBOU HERD DELIMITATION AND SEASONAL MOVEMENTS BASED ON SATELLITE TELEMETRY ON VICTORIA ISLAND 1987-89.

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ECONOMIC DEVELOPMENT

GOVERNMENT OF THE NORTHWEST TERRITORIES
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ABSTRACT

This report describes the fitting of satellite collars to 15 caribou cows on Victoria Island between 1987 and 1989, and aerial surveys to delimit calving distribution and verify if the collared cows successfully calved. Our objectives were to determine the number of caribou herds on Victoria Island; to describe their seasonal movements; and to determine if the calving grounds would be suitable for subsequent surveys to estimate caribou numbers. We identified two herds (Minto Inlet and Dolphin and Union) based on their geographically separate calving and rutting distribution. We used the satellite collars to demonstrate that the cows aggregated together for calving and had affinity to calving areas for at least 2 years. Our expectation that delineating calving grounds would be useful for future surveys to estimate herd size was not met as the boundaries were diffuse and difficult to delineate. Instead, we suggest surveying the rutting distribution for the Dolphin and Union herd as the caribou congregate along the south coast of Victoria Island.

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INTRODUCTION

Caribou (*Rangifer tarandus*) have returned to Victoria Island after disappearing from the area in the early 1900s (Manning 1960, Gunn 1990). Historically, the island had been home to a northwestern resident herd and a large southern migratory herd that crossed the Dolphin and Union Straits (Figure 1) to the mainland for the winter (Manning 1960). Caribou from the two herds were reported to be distinct in appearance, but skins and skulls were only collected from the southern migratory herd, which Manning (1960) called the Dolphin and Union herd.

After the early 1900s, hunters reported almost no caribou on Victoria Island until the 1970s, when sightings became more numerous on southern Victoria Island and hunting increased (Gunn 1990). By the late 1980s, hunters from Holman, Kugluktuk and Cambridge Bay were annually taking approximately 2000 to 3000 animals (Gunn *et al.* 1986). The harvest was high relative to the only population estimate (7936±1118 caribou), which was based on an aerial survey over western and central Victoria Island in August 1980 (Jakimchuk and Carruthers 1980). Hunters, however, reported increasing numbers of caribou wintering along the south coast of the island and close to Cambridge Bay in the mid -1980s, which indicated that caribou numbers may have been increasing (Gunn *et al.* 1997).

To gauge the effect of harvest on the caribou population, we needed to estimate trends in caribou numbers and seasonal distribution. Victoria Island is too large an area (218,129 km^2) to readily contemplate surveying the entire island, which has been the approach used for other arctic islands. An alternative method, used for the large mainland caribou herds, is to determine the trend in the number of cows that annually aggregate on their calving grounds (Heard 1985). Caribou cows usually return to the calving ground they were born on, making calving grounds (Gunn and Miller 1980, Heard and Stenhouse 1992) a relatively predictable survey area.

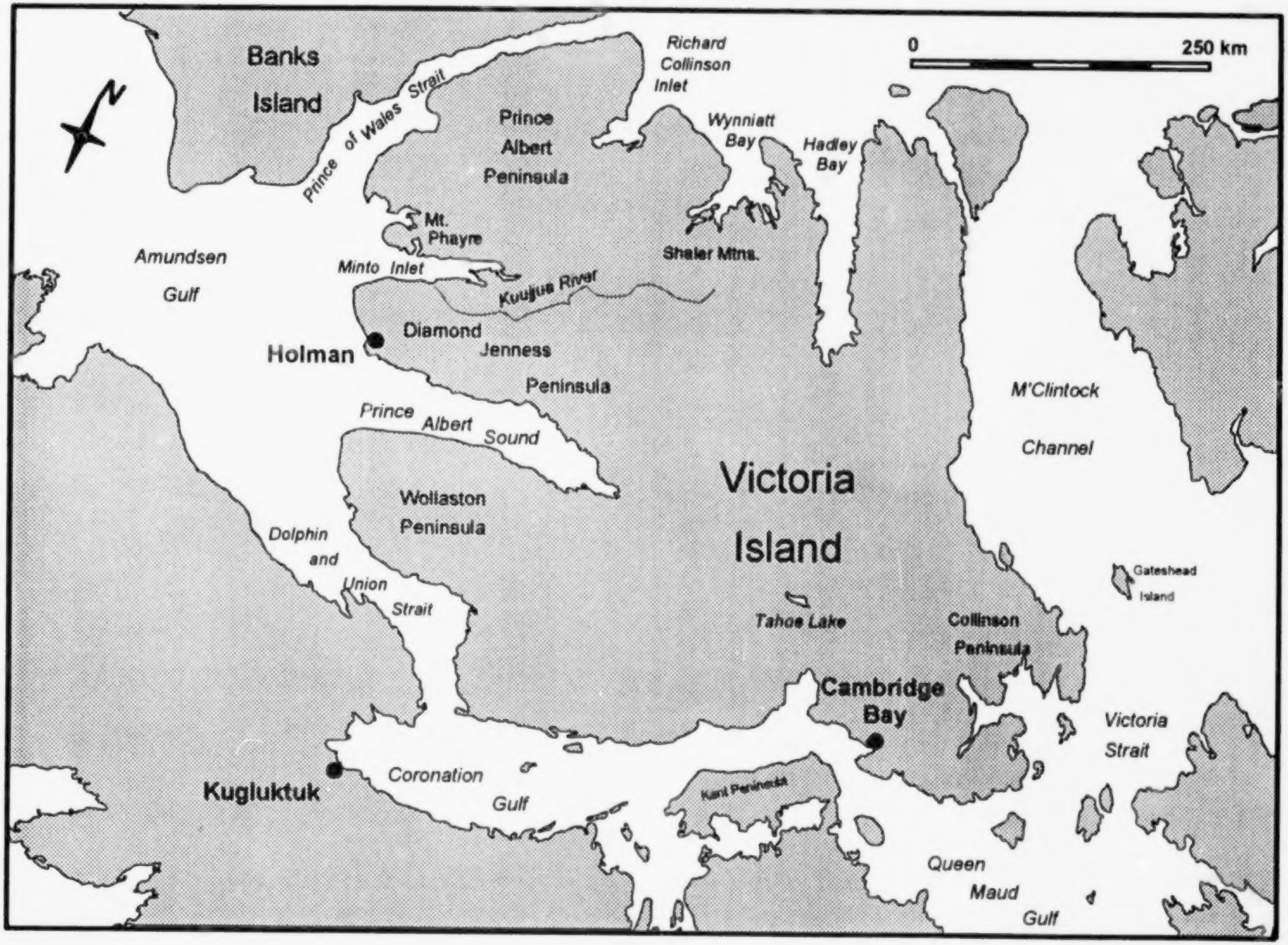

Banks
Island
Prince of Wales Strait
Prince
Albert
Peninsula
Richard
Collinson
Inlet
Wynniatt
Bay
Hadley
Bay
0
250 km
Mt.
Phayre
Amundsen
Gulf
Minto Inlet
Kuujjua River
Shaler Mtns.
Holman
Diamond
Jenness
Peninsula
M'Clintock
Channel
Prince
Albert
Sound
Victoria
Island
Wollaston
Peninsula
Dolphin
and
Union
Strait
Gateshead
Island
Tahoe Lake
Collinson
Peninsula
Cambridge
Bay
Victoria
Strait
Kugluktuk
Coronation
Gulf
Kent Peninsula
Queen
Maud
Gulf

Figure 1. Victoria Island communities and geographic localities.

Conventionally, caribou biologists have followed Thomas (1969) who identified barren-ground caribou herds based on the return of cows to a traditional calving ground, the most consistent range used annually (Skoog 1958). The supposition is that the cows that return to a particular calving ground all belong to the same herd. Herds and populations are terms often used interchangeably and refer to groups of conspecific individuals that are demographically, genetically, or spatially disjunct from other groups of individuals (Wells and Richmond 1995).

Almost all descriptions of traditional calving grounds refer to barren-ground caribou. Information for Arctic Island caribou is lacking. Urquhart (1973), however, documented annual concentrations of calving cows on northwest Banks Island and Inuit identified western Victoria Island as an area where caribou calve. Thus, we decided to test whether the caribou on Victoria Island annually return to traditional calving grounds and whether calving ground surveys would appropriate for determining population trends.

To identify herds and estimate trends in numbers of caribou, we had to first locate and define calving grounds. Victoria Island's large size precluded aerial searches in June in the hope of finding calving caribou, although we did know from hunters that caribou that wintered on southern Victoria Island used to calve on western Victoria Island. People in Holman suggested that calving took place inland on Prince Albert Peninsula and on Wollaston Peninsula. However, we had no information on the extent of caribou seasonal movements. Consequently, we decided the most effective technique to locate calving areas would be to use the unlimited range offered by satellite tracking.

Herd definition based on calving distribution would be strengthened if we knew that cows that calved together were also being bred together. Thus, we wanted to test whether cows that calved together were also closer to each other during October (the rut) than they were to cows that calved on other calving grounds.

As well as calving distribution, we were also interested in describing the seasonal movements of caribou on Victoria Island. We needed to understand seasonal distribution to be able to associate harvesting with individual herds. We knew, for example, that in the 1980s people from Holman hunted caribou around Minto Inlet during the winter but around Prince Albert Sound in the summer. Whether that harvest was from one, two or more herds was uncertain. Previously there had been two herds on Victoria Island (Manning 1960) which is why we were anticipating that there may currently be more than one herd. Satellite tracking would allow us to describe both seasonal movements and rutting distribution.

In this report, we describe fitting satellite collars on caribou cows on Victoria Island between 1987 and 1989, and the aerial surveys to delimit calving distribution and determine whether collared cows calved successfully. The study's objectives were:

1. to determine the number of distinct caribou herds on Victoria Island;
2. to describe their seasonal movements and distribution.
3. to determine if calving grounds would be suitable for subsequent surveys to estimate caribou numbers; and

Ten years have passed between completion of the study and this report, although results were presented to the communities and Regional Hunters and Trappers Organization as a series of posters and presentations. During the lengthy time this report has been in the making, other studies have followed up on the results reported here and reference is made to those studies in the Discussion.

METHODS

Study Design

Number Of Caribou Herds

The conventional definition of a caribou herd is based on the annual return of cows to a traditional calving ground. To determine the number of caribou herds on Victoria Island we first needed to determine whether cows came together (aggregated) for calving in a particular geographic area (calving ground). Secondly, we needed to demonstrate that the cows showed fidelity to the calving ground, meaning that they returned the following year. Using calving grounds to define herds would be strengthened if the cows that calved together also bred (rutted) together.

Aggregated calving: We established two criteria to identify calving aggregations:

(a) Satellite-collared cows would calve with other cows in their vicinity. We arbitrarily defined this as 5 cow-calf pairs or breeding cows (cows with hard antlers or uddered cows with or without hard antlers) within 2 km of the collared cow.

(b) We assumed that a calving ground is an area where calving cows aggregate, separated from other aggregations by areas without breeding cows.

Fidelity: We established two criteria to identify fidelity to calving grounds:

(a) The criterion for individual affinity to a site would be whether a pregnant collared cow returned to the previous year's calving site or within an arbitrary 20 km of that site.

(b) The criterion for fidelity by unmarked cows would be overlap between the calving grounds in the two years of the study. We arbitrarily set the overlap at 60%.

Suitability Of Calving Grounds For Population Estimation

We would determine the timing of calving from the collared cows and the peak of calving from the maximum ratio of calves to cows observed during aerial surveys. We would determine the calving ground edge by the distance between cows with calves along the transects.

Satellite-Collaring

The collars (Telonics Inc. Arizona, U.S.A.), complete with battery and VHF transmitter, weigh about 1600g. We painted the machine belting bright yellow to improve the collar's visibility as some hunters wanted to be able to see the collar. The transmitter duty cycles were programmed to transmit 6h on and 18h off between 20 May and 20 June and 6h on and 114h off during the remainder of the year. This normally resulted in receiving location data every 5 days during most of the year and every day during the calving period. Under this regime the expected battery life was 2.5 years commencing 15 March 1987.

The collars used for this study were equipped with an internal temperature sensor and a motion detector (mercury tipswitch) to detect short-term and long-term activity. Short-term activity was indicated by the sum of tipswitch movements for the minute prior to the time of the message and long-term activity was indicated by the sum of movements for the previous 24 hours. The latter was also used as an indicator of mortality if it showed a value of zero over a short time period.

We divided the central and western island into 11 even-sized blocks to geographically spread collar deployment to increase our chance of including more than one herd. We searched the blocks using a Bell 206b Jet Ranger helicopter flown at an altitude of 75 to 150 m above ground level and at cruising speed (140 km/h).

From the air, we scrutinized caribou groups for animals with hard antlers that were followed by short yearlings. Those groups were checked more closely to ascertain whether they included adult cows (presence of a vulval patch). The helicopter turned away and circled until the shooter with the hand held net gun, seated in the rear right seat, was ready with the shooting window open. The front seat observer timed the chase on a stop-watch from the time the caribou started to gallop in response to the on-coming helicopter. The front seat observer indicated to the pilot which animals to follow and identified the particular cow to the shooter. The pilot flew the helicopter to within a few meters above and along side the cow to position the net gun shooter. We landed the helicopter close to the cow in the net after a successful shot.

We restricted pursuits to <60 sec when ambient air temperatures were less than -35°C and no animal was pursued for >120 sec when ambient air temperatures exceeded -35°C. The short chases were to minimize respiratory distress from the cold air and reduce the possibility of overheating. To reduce the likelihood of injuries, we aborted the chase if the pursued caribou headed to wind-blown bare ground or rocky areas.

We manually restrained the cows rather than using drugs. The cows did not struggle once they were blindfolded and held upright on their briskets by firm pressure on their antlers and across their withers. We then worked them free of the net and checked that the cow had fully erupted dentition. The satellite collar was fitted to allow three fingers to slip between the collar and the neck. We released the cow as soon as the collar was fitted and the restraining nuts tightened. To reduce handling time, we took no measurements or samples.

In April 1988 we retrieved transmitters from four cows that died. We took those four transmitters and one new transmitter and fitted them to two cows on southeastern Victoria Island and three cows on western Victoria Island. The collars were retrieved in May and June 1989 by shooting the cows. Samples were taken for on-going taxonomic and seasonal condition studies. We took skin samples from under the collars of five cows, fixed them and sent them to the Western College of Veterinary Medicine for microscopic examination.

Calving Distribution

We located cows in June 1987 and 1988 using satellite locations and radio-tracking from a fixed-wing Helio-Courier aircraft on wheel skis. In June 1987, we tried to check each cow several times to pinpoint, within a day or two, when the cow calved. This allowed us to compare the calving date to daily distance traveled and the cow's activity level as monitored by the collar. In June 1988, we checked each cow only once.

We visually determined if the collared cow had a calf and hard antlers, and whether there were other parturient cows in her vicinity. We used the early June locations as the approximate centre of a search block which we systematically covered by transects to define the limits of calving caribou distribution. The survey crew consisted of a right and left surveyor and the pilot, who navigated and plotted observation numbers on 1:250,000 scale topographic maps. The left observer recorded the sightings for both observers by location number in a field notebook.

The radio-tracking antennae were mounted about 1m on either side of the fuselage on a cross bar bolted on the underside of the fuselage. Boundaries for the inside and outside of the transect were calculated (Norton-Griffiths 1978) and marked by red tape on the wires and windows. The markers were checked against a truck parked 1.0 km from the runway end markers on the Kugluktuk airstrip, by flying over the truck at 150 m above ground level.

The strip transects were oriented north-south to be perpendicular to the long axis of the coastline and the major rivers. The first transect was randomly placed along a line of latitude. The other lines were evenly spaced at 10 km or 20 km intervals. Aircraft altitude was 120 - 130 m above ground level, airspeed was 160 km/h. The transect width was 0.5 km on either side of the aircraft.

Data Analyses

We received location and activity data from Service Argos on computer disks and transferred them into a database (DBase3). We used Sigmastat to analyze distance data and activity indices and we plotted location data using Quikmap and Freelance software.

We calculated minimum (straight line) distances moved between locations at daily intervals during May and June when the satellite duty cycle was set for daily transmissions. When the duty cycle was set for transmissions every 5th day, we calculated the distance moved at monthly intervals. Because the test for normality failed, we used the Kruskal Wallis Oneway ANOVA test to determine if monthly distances traveled significantly differed between individuals and between years. Comparisons between individuals of total distance moved monthly (ANOVA) resulted in unequal variance so that an ANOVA on ranks was applied (Kruskal-Wallis).

We used calendar months for comparisons and describing seasonal movements because they offer the convenience of standardized time periods. However, we recognize that many ecological processes are independent of calendar months. We inspected daily location and activity data to determine pre-calving and post-calving movements and to select probable calving dates. We used the date of a conspicuous increase in movement during May or June as the beginning of pre-calving. We summed the minimum straight line distances moved from this date until calving, which was identified by a period of minimal change in daily location in June. Calving dates were verified by aerial observations.

Distances traveled from her calving location were measured for each cow as she traveled throughout the seasons. We compared those distances for every pair-wise combination of cows using linear correlation. Annual location data, collected every 5 days, was used to determine whether seasonal movements were similar between the three possible herds.

Annual movements from the calving site were analyzed by calculating the distance an individual cow moved from the calving location. These distances were compared between individual cows using an ANOVA on ranks (Kruskal-Wallis). These movements were also compared between groups.

The total distances moved during daily satellite reception (May 20 - June 20) were calculated for each cow for each year. A t-test was applied to compare these total distances between the northwest and south-central groups.

To test for fidelity between 1987 and 1988 calving locations, we measured the distance between the annual calving locations for individual cows. Because location data was collected daily during the calving period, we also compared the location of individual cows on the specific date of calving between years by calculating the distance between calving locations in 1987 and 1988 for the same cow.

To test whether cows that calved together were also closer together during October (the rut) than to cows that calved on other calving grounds, we examined the measured distances between cows at calving and the rut. We selected three dates in each of June and October that showed minimum activity indices and movement and assumed these indicated calving and the rut. The three values for distance between cows for each month were averaged to calculate a single relative distance between each cow.

RESULTS

Capture and Collaring

We caught 13 caribou and collared 10 adult cows between 14 and 30 March, 1987 (Figure 2). We released, without collaring, three cows who did not have permanent lower canine teeth and may not have reached breeding age.

We observed no injuries to caribou during the chases. Only one caribou of the 11 handled had a minor injury - an incisor tip broke off when the cow struggled in the net. One cow was tangled in the net but freed herself before we reached her.

We fired the net unsuccessfully on 23 occasions. The net missed 10 times as the caribou were extraordinarily agile and the net misfired. The caribou seemed able to perceive variations in the snow surface and avoided soft patches of snow to stay on the hard packed snow where they could twist and turn. The other 13 misses were misfires in which the net did not spread out. We carefully cleaned the snow out of the cylinders and coated the net weights with powdered graphite but these precautions were not sufficient to prevent the weights from freezing in the cylinders in -35 to -40°C temperatures.

Ferry time for the helicopter was 13h between Inuvik, Holman and Cambridge Bay. The numbers of hours for search and capture of the caribou was 45 h.

Mean pursuit time for collared cows was 100 ± 37s (S.E.); two pursuits exceeded 120s (129s and 125s). Handling time from when the net hit the cow to when she was released averaged 14 ± 4 min. Most of this time was taken untangling the net from the cow.

Cow 7760 was conspicuously small-bodied and short-faced, and had a mostly white pelage, resembling *R. t. pearyi*. The other cows northwest of Minto Inlet

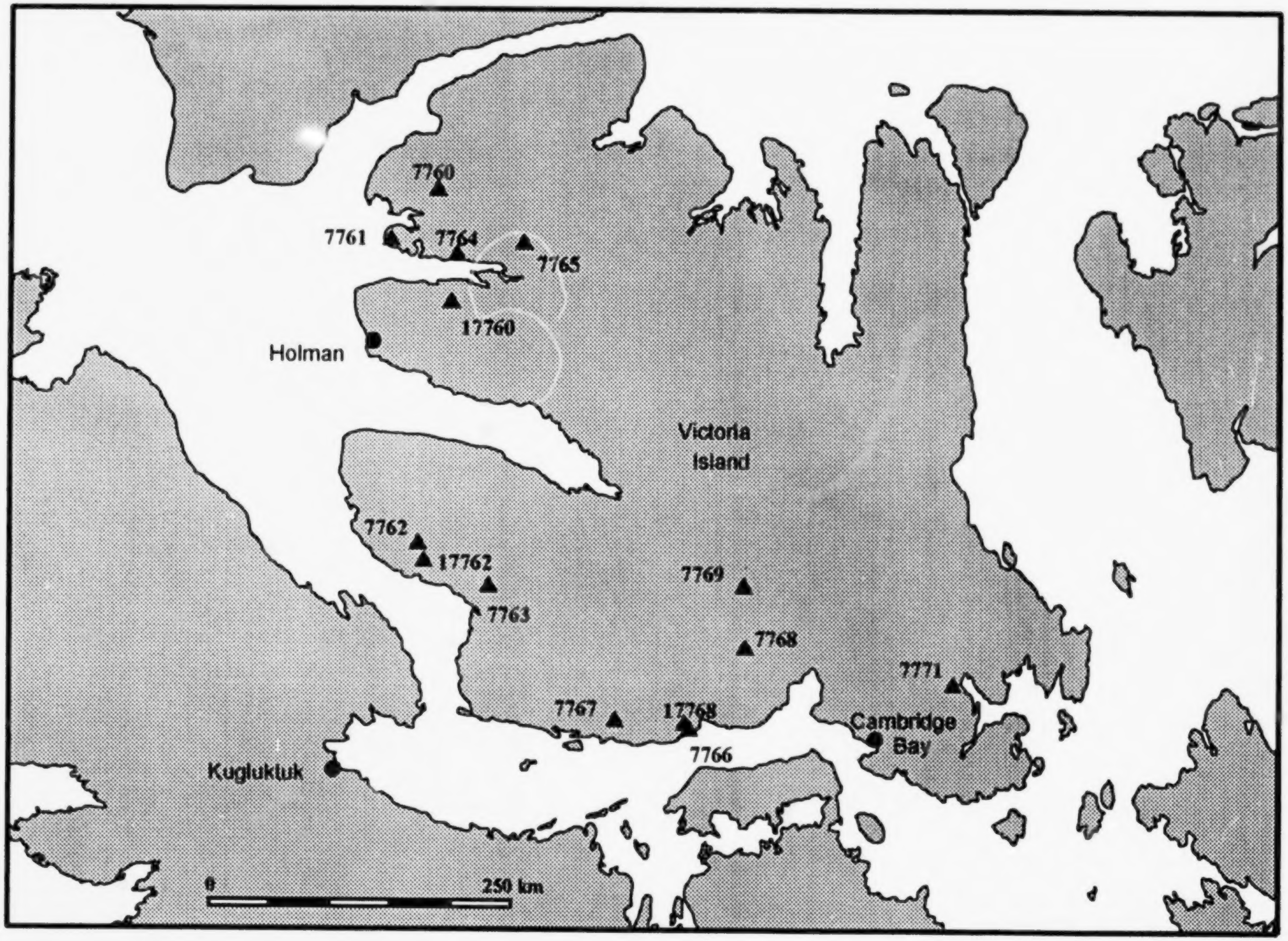

7760
7761
7764
7765
17760
Holman
Victoria Island
7762
17762
7763
7769
7768
7771
7767
17768
7766
Cambridge Bay
Kugluktuk
0
250 km

Figure 2. Locations on Victoria Island where caribou were fitted with satellite transmitters, April 1987 and 1988.

were slightly larger and darker than cow 7760. Cows south of Minto Inlet were larger, had slightly longer faces, and had more brown on their foreheads and backs than Peary caribou. Their proportions (short faces and legs) and pelage were conspicuously different from barren-ground caribou *R. t. groenlandicus*.

During the capture in 1987, all collared cows except cow 7762 were found in areas that had other scattered groups of caribou. Cow 7762 had no other caribou with her except her bull calf. Groups of caribou were most evident on Mt. Phayre peninsula (between Walker Bay and Minto Inlet) and the coastal lowlands of the southern coast of central Victoria Island inland to Tahoe Lake.

Cows 7762, 7763, 7764, 7766, 7767, and 7768 were in cow-calf pairs when collared (Figure 2). Cows 7765 and 7769 were in small groups with another cow, yearling and calf; cow 7761 was with another cow and 7760 was alone although there were other groups close by.

Of the 10 caribou collared in March 1987, seven were alive and had fully functional collars on 31 January, 1988. One cow (7764) was shot at the end of March 1987, within a few days of being collared. The hunter returned the collar and he asserted that the collar was too tight and was on a bull. The hunter explained that he had not seen the collar when he shot the caribou as it was running away. The head he provided was a mature bull (no antlers) with the neck cut off. Anne Gunn sent an explanatory letter to the HTA and discussed it with the HTA President and several members in June 1987.

After 9 May, cow 7760 transmitted zero activity and her coordinates remained unchanged (Figure 3). On 5 June, we flew to a satellite-tracked location and homed in using radio-tracking to retrieve the collar. The carcass had been scavenged by foxes and reduced to a leg bone, skull and rumen. The humerus marrow was red jelly and the molar teeth were worn to the gum line, which suggested that inability to grind food contributed to or caused malnutrition. We

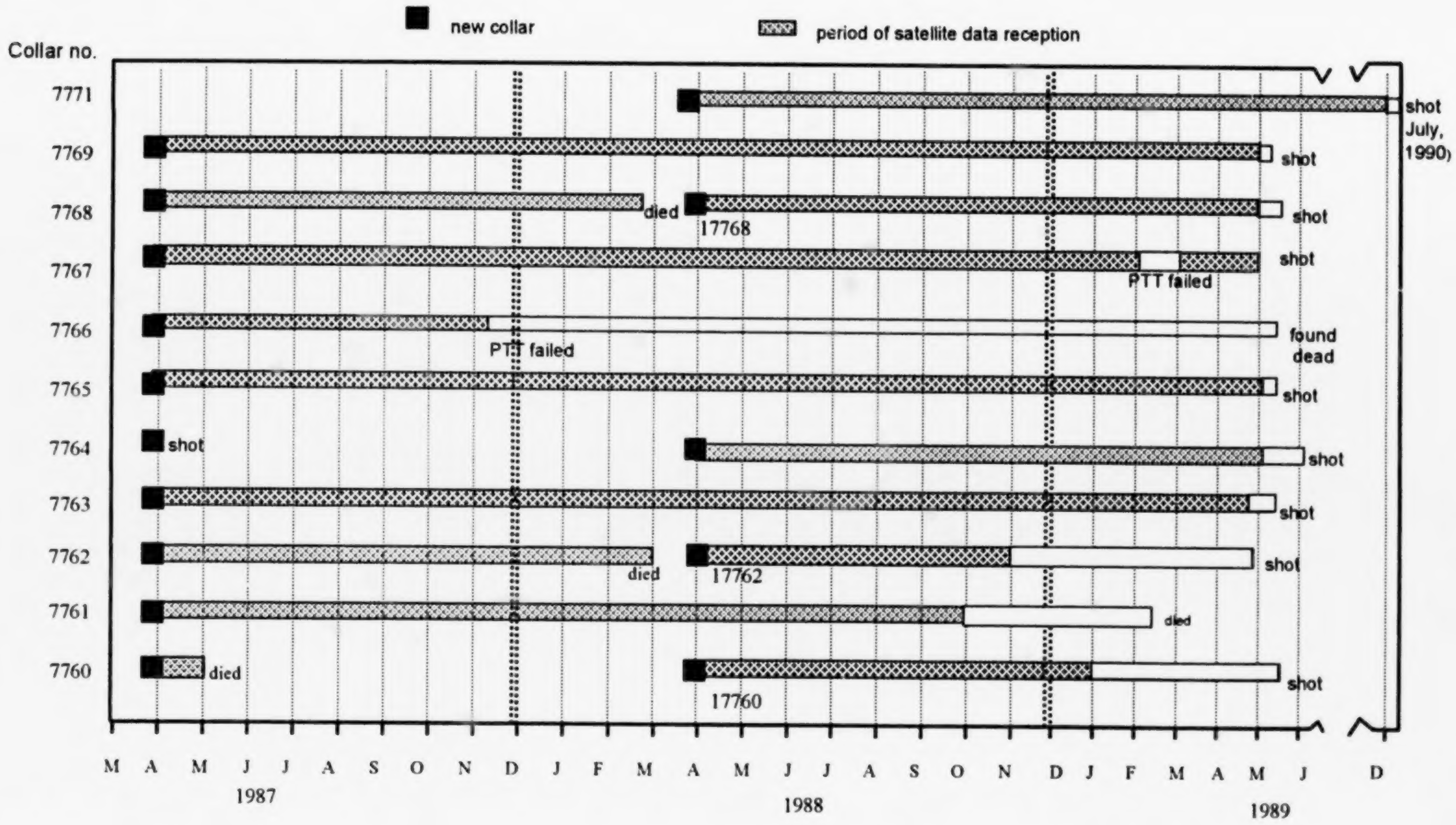


Figure 3. Months and years for satellite transmissions from individual caribou, 1987-1989, Victoria Island, NWT.

had noted her worn incisors when we caught her but her flanks had been well rounded and she had seemed relatively fat.

Location data was received continuously for four of the ten collared cows from April, 1987 to May, 1989 (Figure 3). Cows 7760 and 7764 died early in the study (April and May, 1987). Only eight months of location data was collected for cow 7766 because satellite reception failed in November,1987. This cow was found dead in 1989. Cows 7762 and 7768 died in February, 1988. Cow 7761 died in February, 1989.

In April 1988, five new cows were collared and fitted with one new and four re-used collars 7760, 7762, 7764, and 7768 (the re-use is identified with the prefix 1; eg 17760). This resulted in 13 more months of location data for three of these cows and at least eight months for two.

With the exception of cow 7771, all of the cows were collected and their collars retrieved during the final fixed-wing survey in May, 1989. The aircraft landed a wildlife officer near each cow, which was shot, sampled and the meat brought to the nearest community. Cow 7771 was collected in July 1990 and her calf was collected at the same time.

Annual and Seasonal Distribution and Movements

***Location of calving grounds*:** Inspection of the June distribution of collared cows (Figures 4-15) shows three areas used for calving - the northwest, southwest into south-central, and southeast portions of Victoria Island (Figure 4). The three areas used for rutting (Figure 5) were northwest, southwest and southeast Victoria Island. Based on a lack of overlap in calving and rutting areas, we identified two distinct groups of collared cows, which we termed as representing two herds.

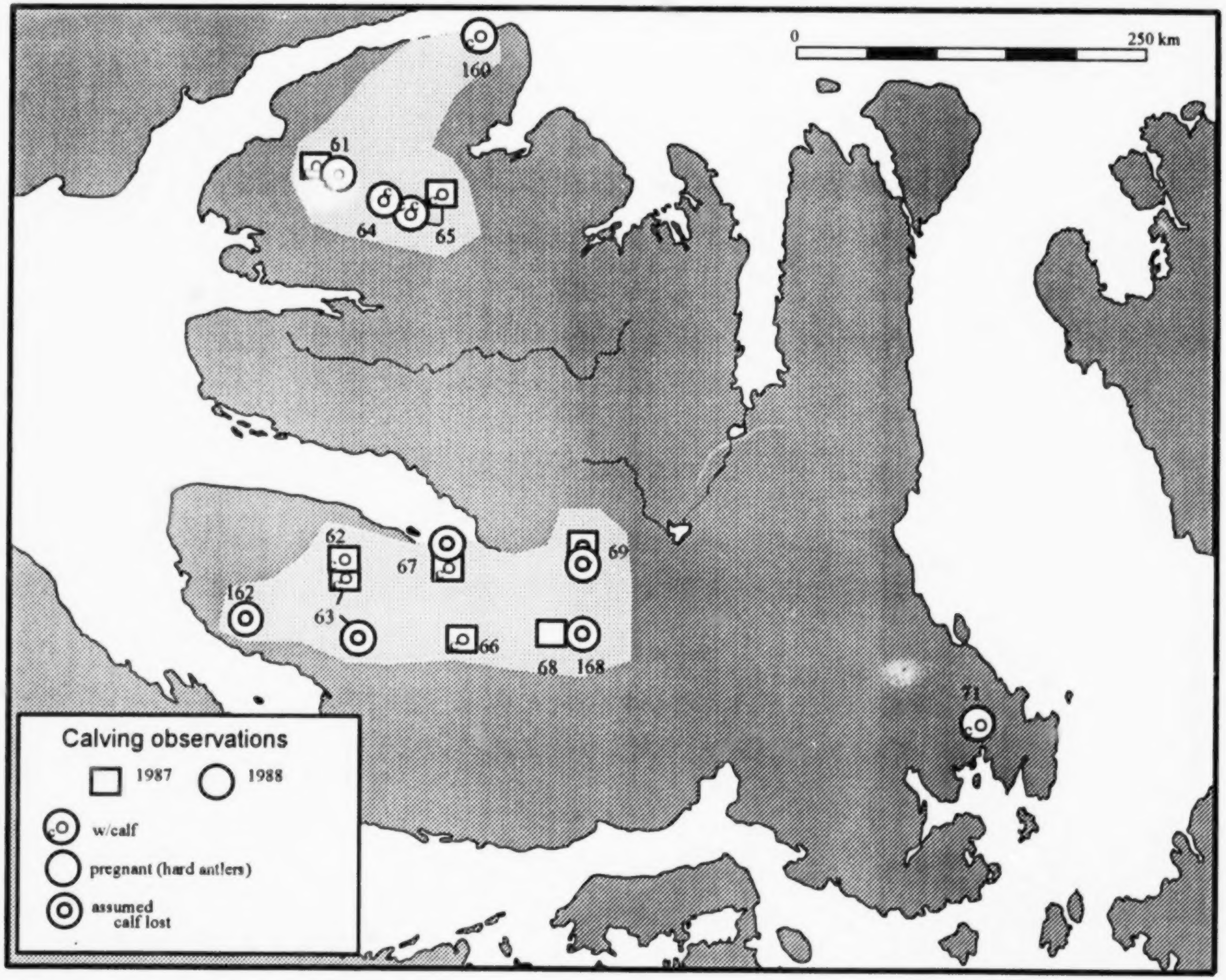

0
250 km
160
61
64
65
62
67
69
162
63
66
68
168
71
Calving observations
1987
1988
w/calf
pregnant (hard antlers)
assumed calf lost

Figure 4. Locations and calving status in June 1987-89 for caribou cows fitted with satellite transmitters, Victoria Island, NWT.

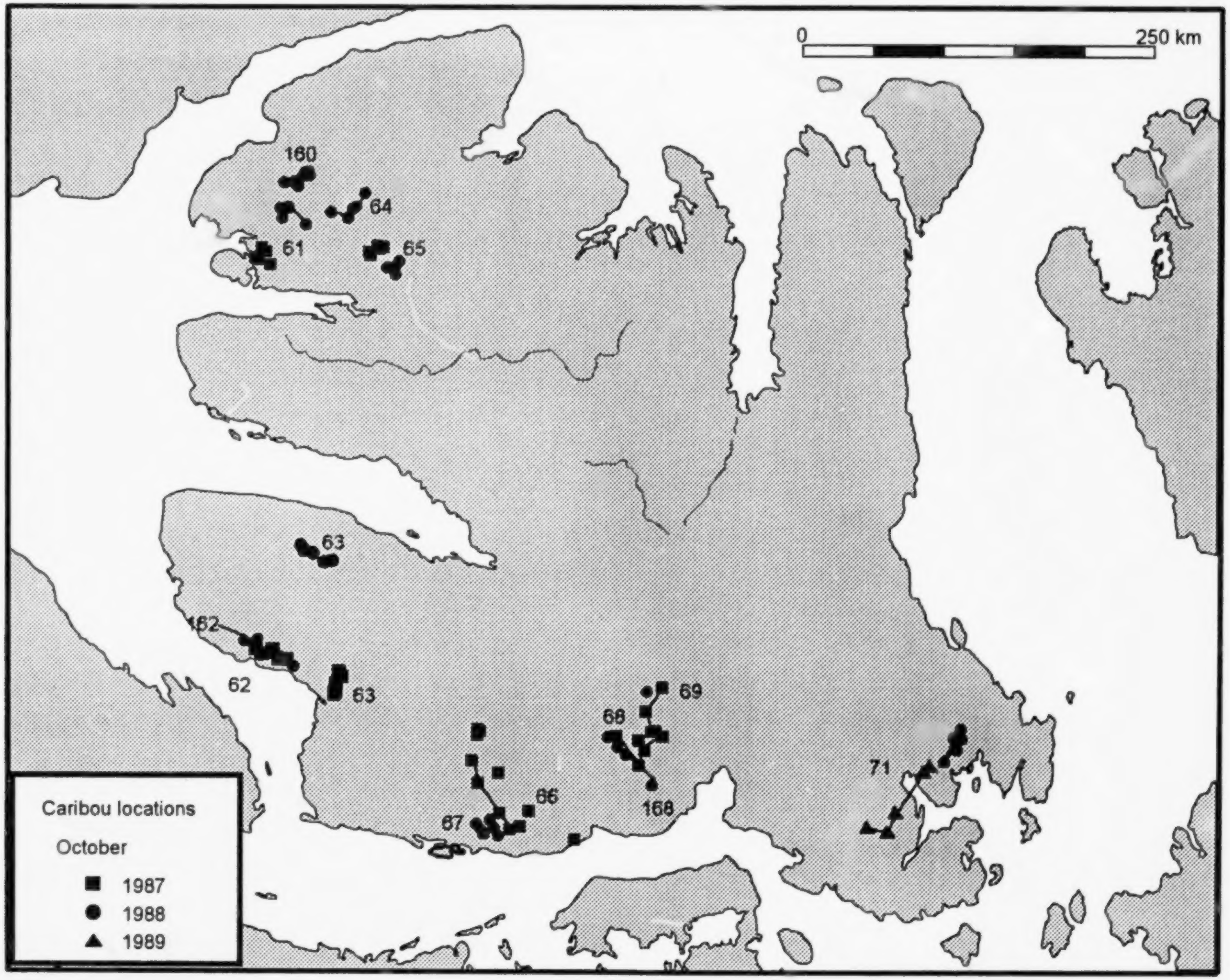

0
250 km
160
64
61
65
63
162
62
63
68
69
66
67
168
71
Caribou locations
October
■ 1987
● 1988
▲ 1989

Figure 5. Locations in October 1987-89 for caribou cows fitted with satellite transmitters, Victoria Island, NWT.

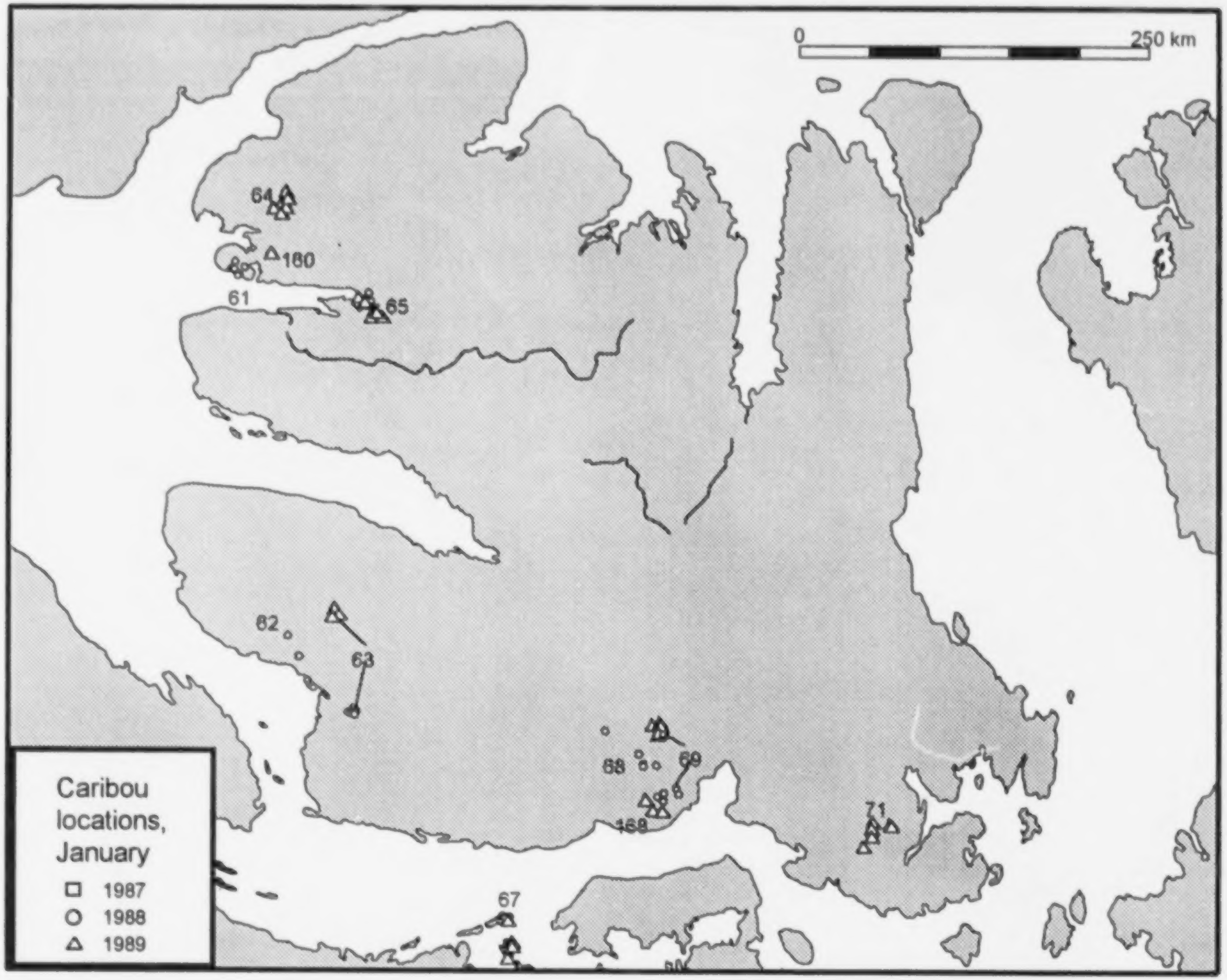

0
250 km
64
160
61
65
62
63
68
69
168
67
71
Caribou locations, January
□ 1987
○ 1988
△ 1989

Figure 6. Locations in January 1987-89 for caribou cows fitted with satellite transmitters, Victoria Island, NWT.

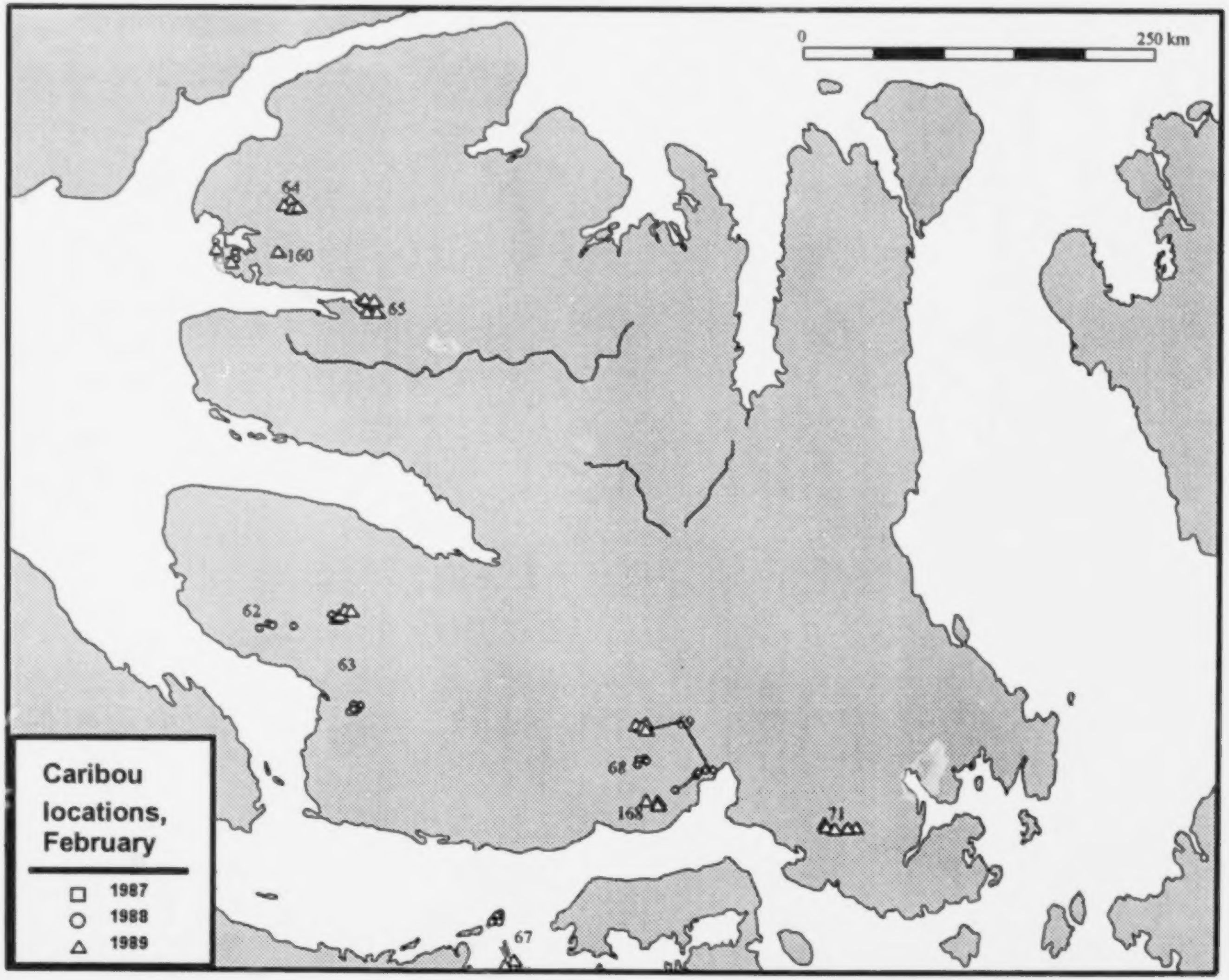

0
250 km
64
160
65
62
63
69
68
168
71
67
Caribou locations, February
□ 1987
○ 1988
△ 1989

Figure 7. Locations in February 1987-89 for caribou cows fitted with satellite transmitters, Victoria Island, NWT.

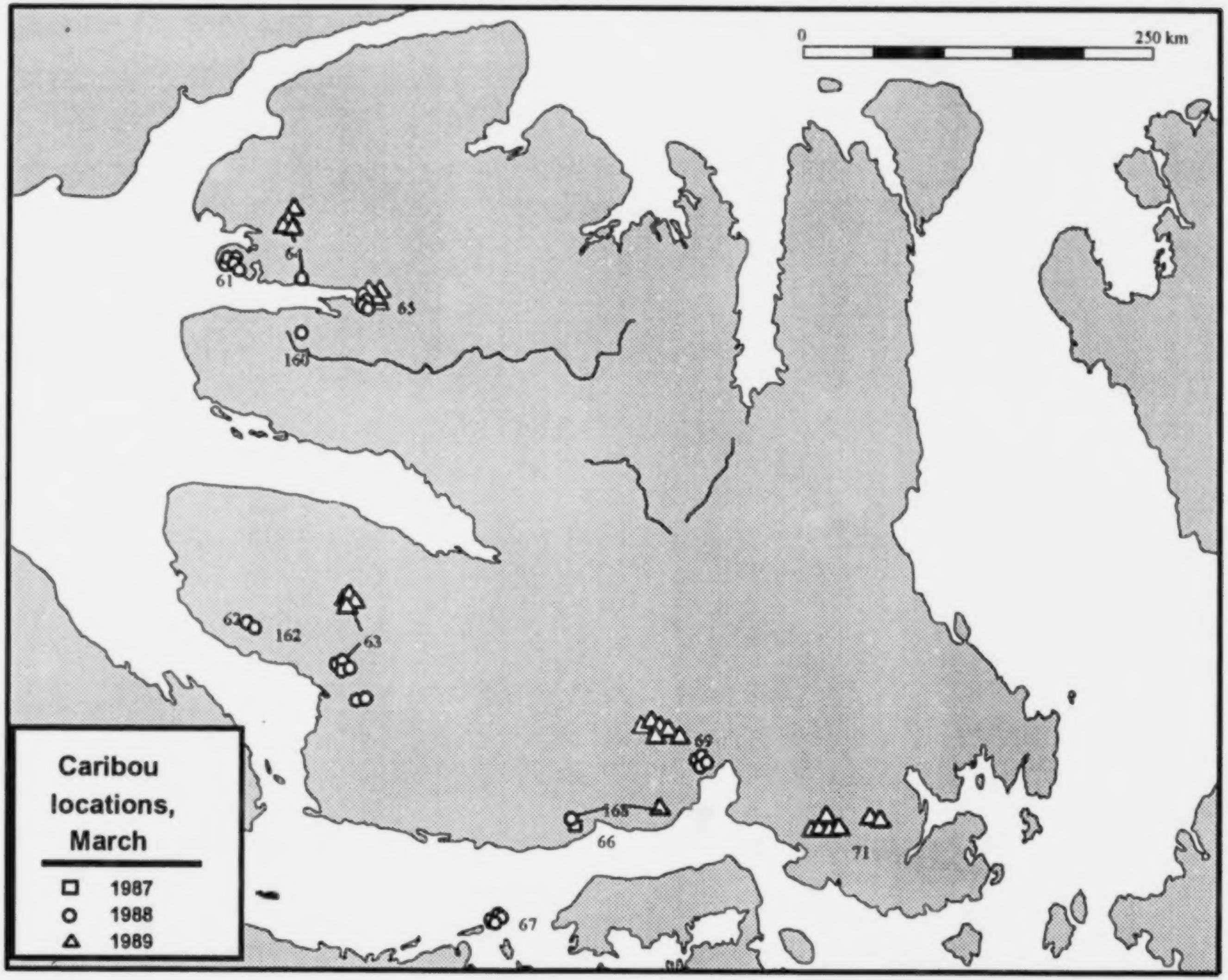

0
250 km
Caribou locations, March
□ 1987
○ 1988
△ 1989
61
64
65
160
62
162
63
69
168
66
71
67

Figure 8. Locations in March 1987-89 for caribou cows fitted with satellite transmitters, Victoria Island, NWT.

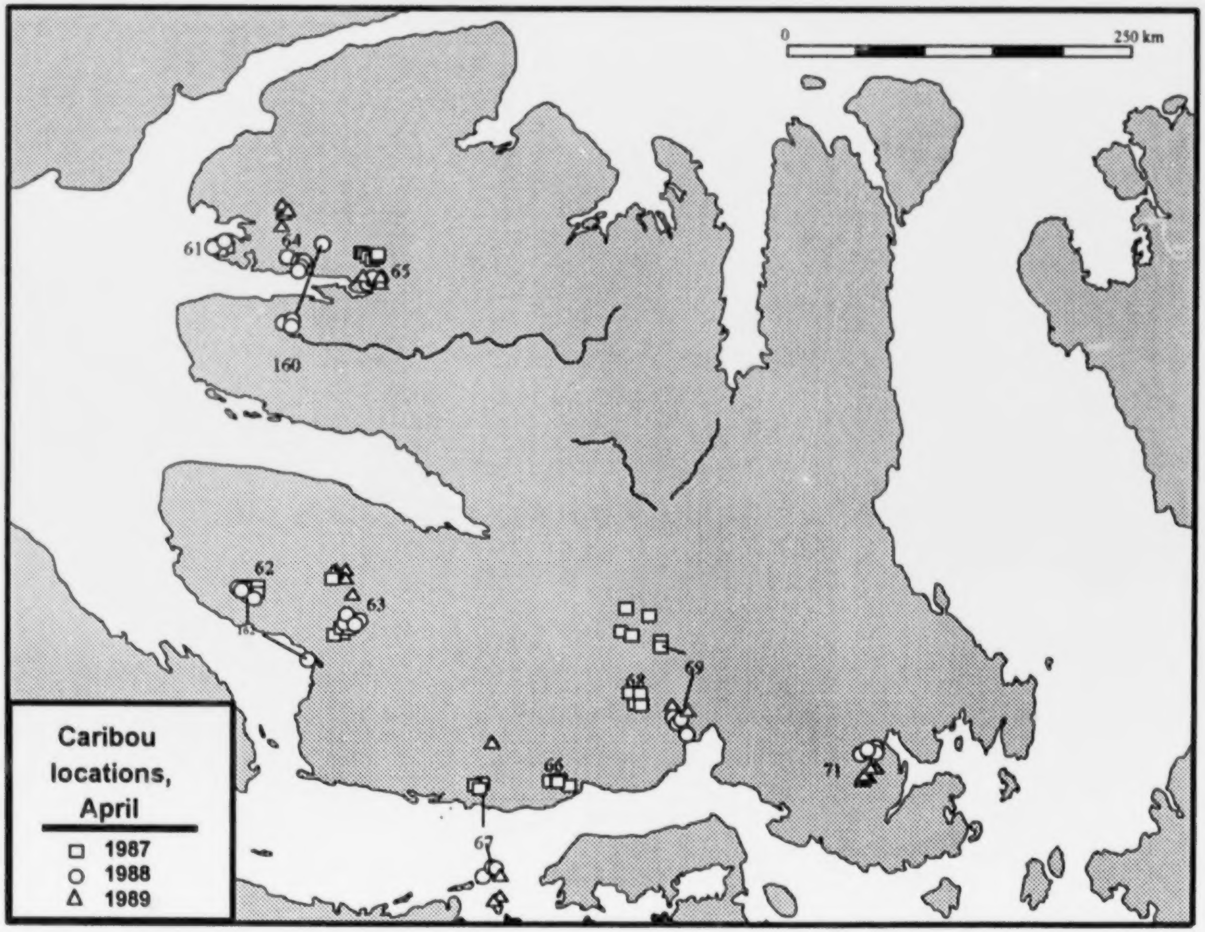
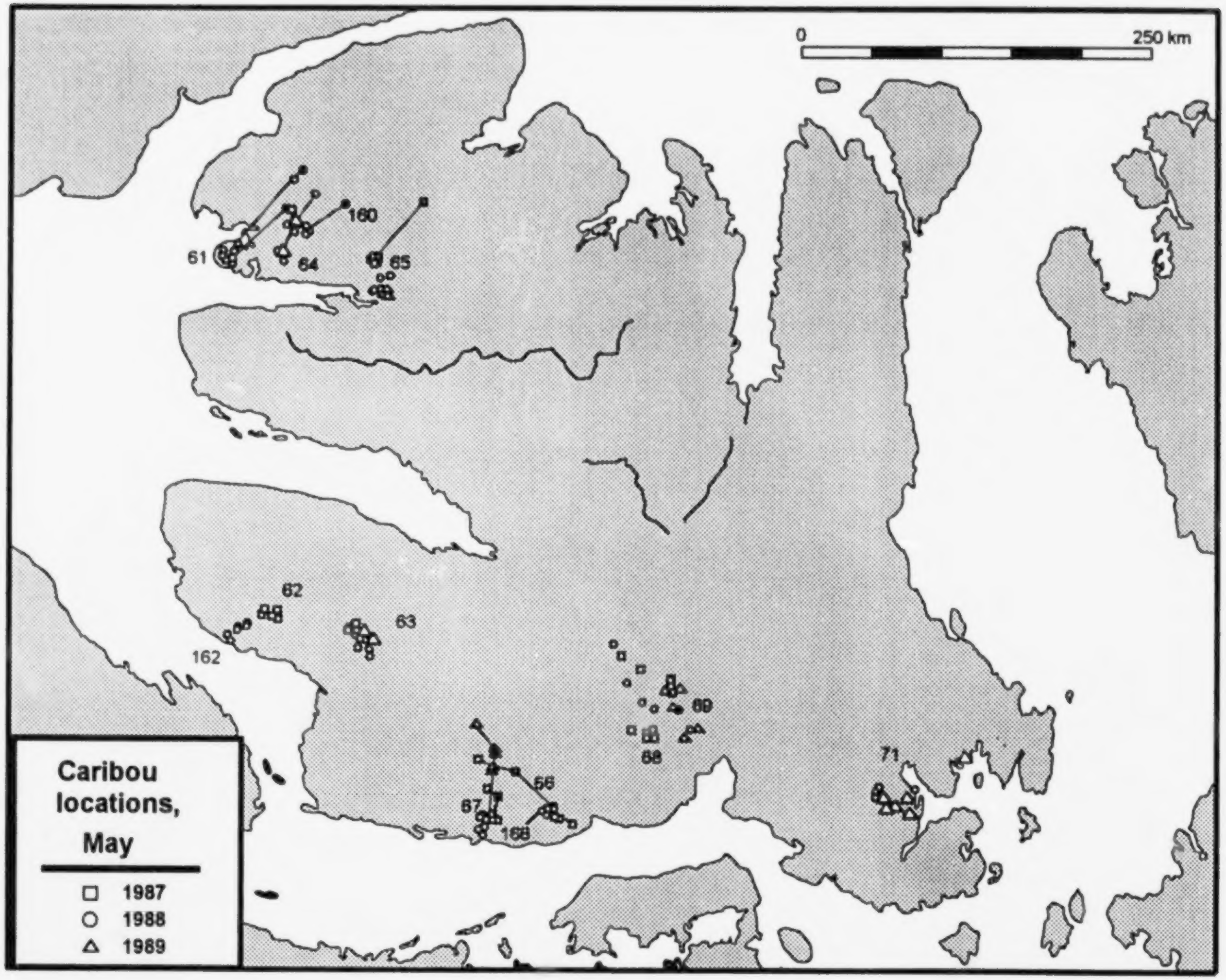

0
250 km
61
64
65
160
62
162
63
66
67
68
69
71
Caribou locations, April
□ 1987
○ 1988
△ 1989

Figure 9. Locations in April 1987-89 for caribou cows fitted with satellite transmitters, Victoria Island, NWT.


0
250 km
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64
160
65
62
63
162
67
166
56
68
69
71
Caribou locations, May
□ 1987
○ 1988
△ 1989

Figure 10. Locations in May 1987-89 for caribou cows fitted with satellite transmitters, Victoria Island, NWT.

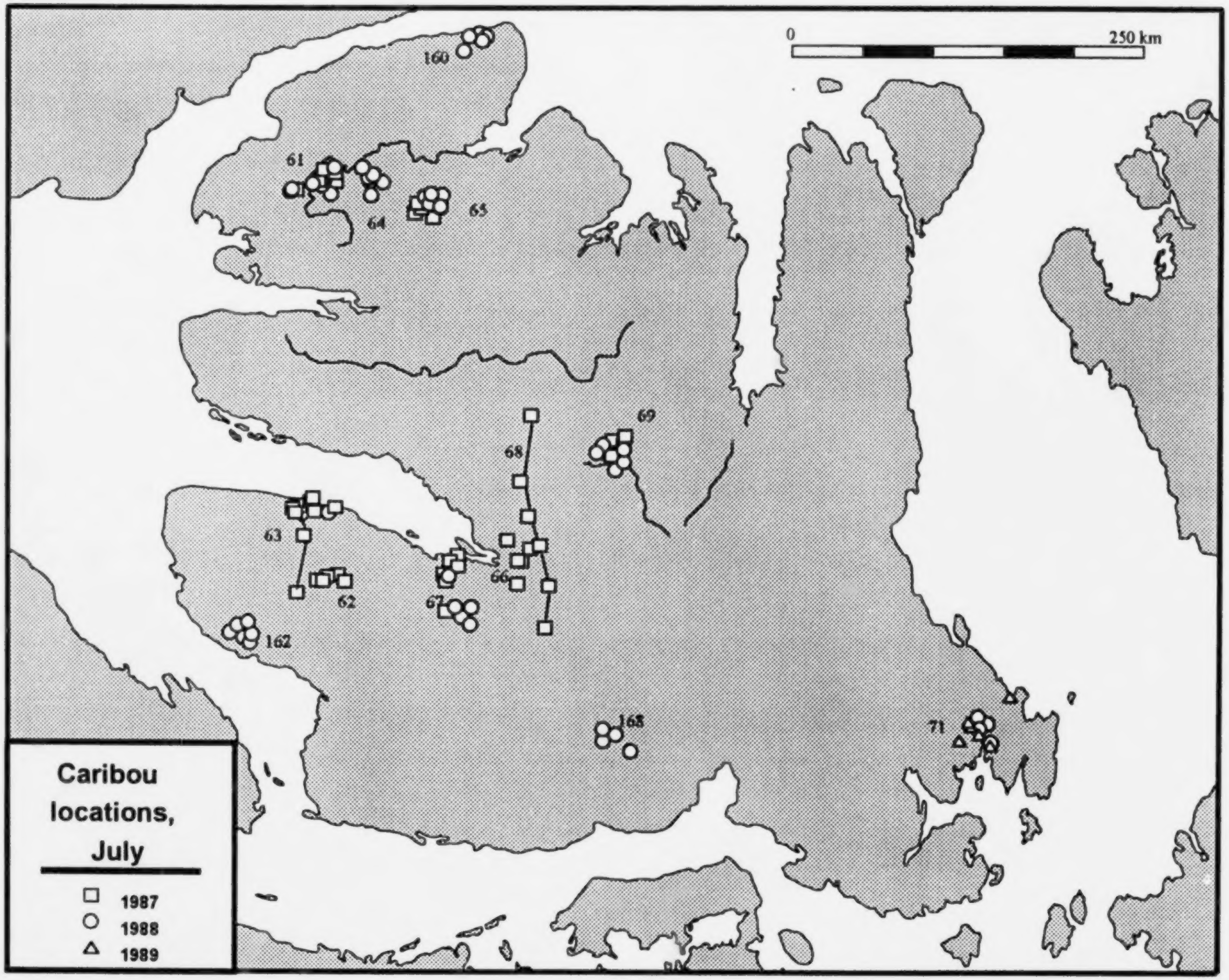
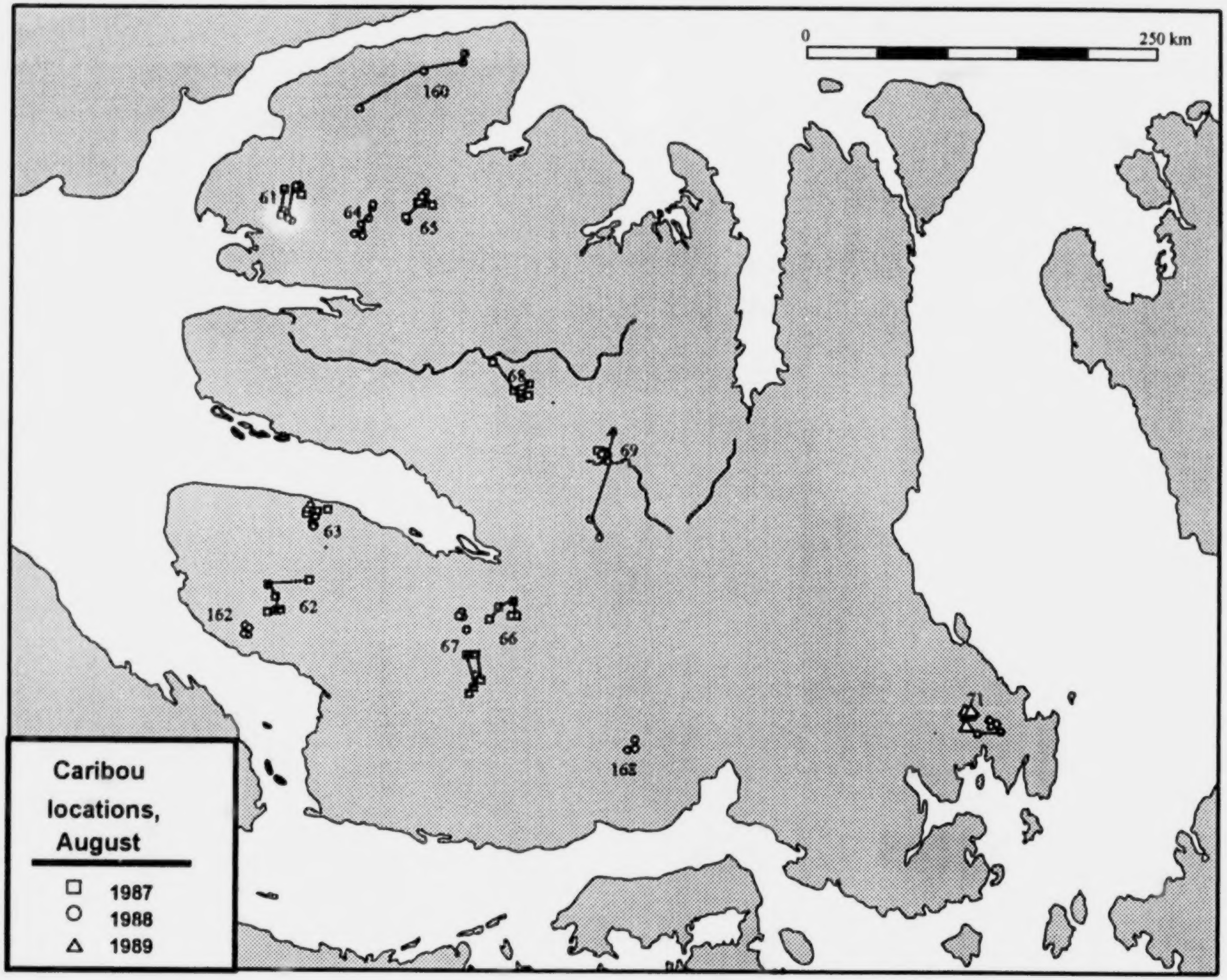

0
250 km
160
61
64
65
69
68
63
62
66
67
162
168
71
Caribou locations, July
□ 1987
○ 1988
△ 1989

Figure 11. Locations in July 1987-89 for caribou cows fitted with satellite transmitters, Victoria Island, NWT.


0
250 km
160
61
64
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68
69
63
62
162
67
66
163
71
Caribou locations, August
□ 1987
○ 1988
△ 1989

Figure 12. Locations in August 1987-89 for caribou cows fitted with satellite transmitters, Victoria Island, NWT.

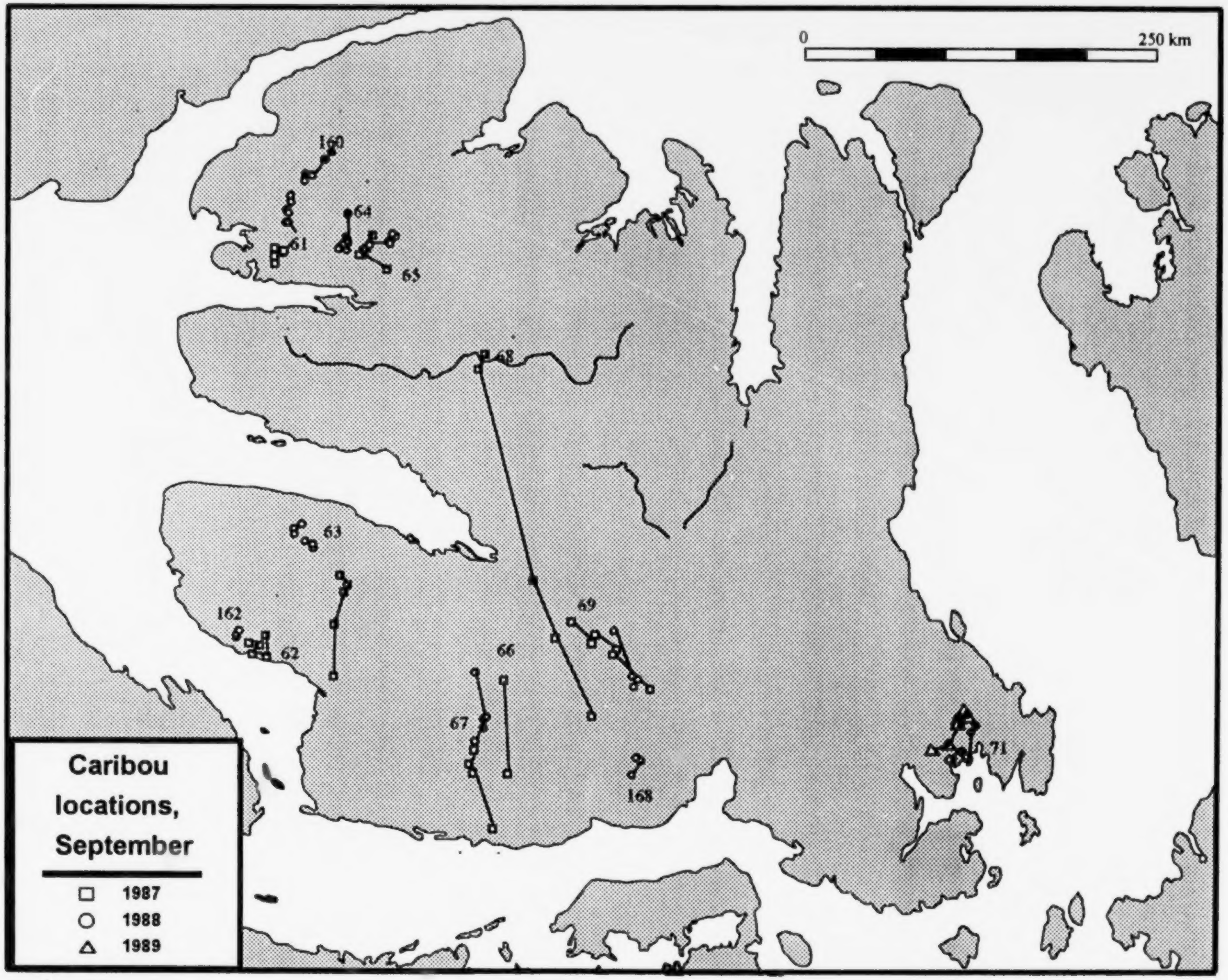

0
250 km
160
64
61
65
68
63
69
162
62
66
67
168
71
Caribou locations, September
□ 1987
○ 1988
△ 1989

Figure 13. Locations in September 1987-89 for caribou cows fitted with satellite transmitters, Victoria Island, NWT.

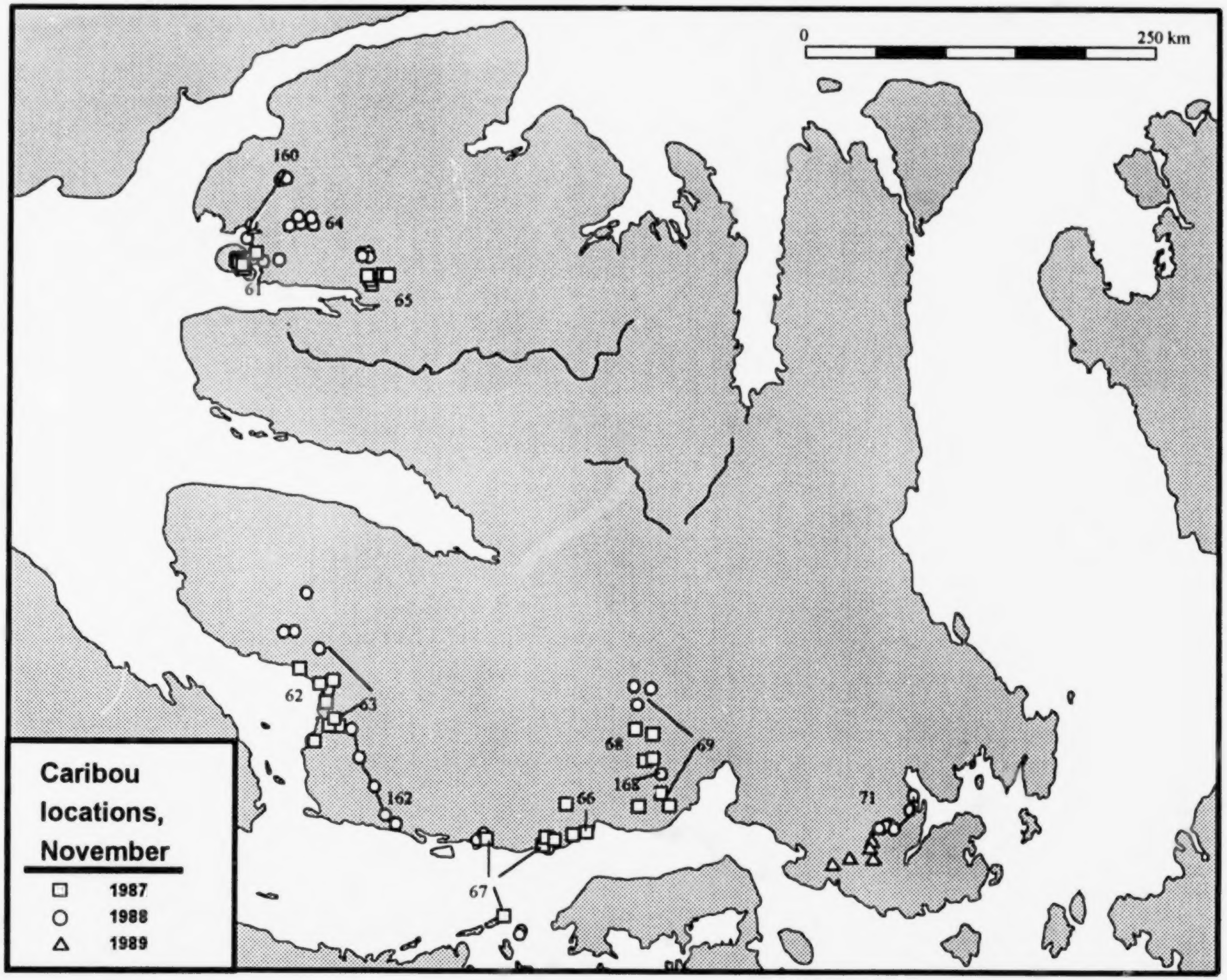

0
250 km
160
64
61
65
62
63
162
67
66
68
168
69
71
Caribou locations, November
□ 1987
○ 1988
△ 1989

Figure 14. Locations in November 1987-89 for caribou cows fitted with satellite transmitters, Victoria Island, NWT.

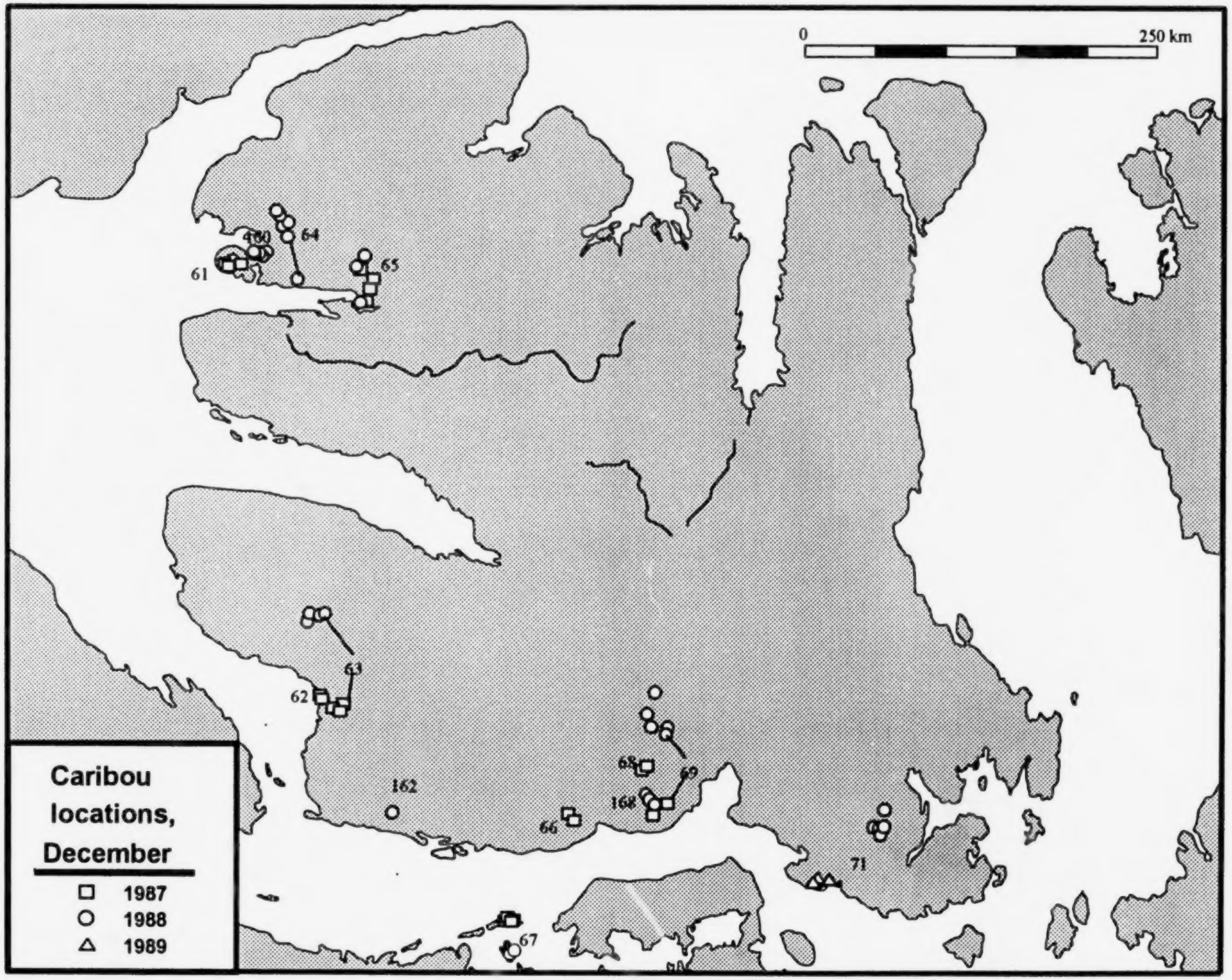

0
250 km
61
460
64
65
63
62
162
66
68
168
69
67
71
Caribou locations, December
□ 1987
○ 1988
△ 1989

Figure 15. Locations in December 1987-89 for caribou cows fitted with satellite transmitters, Victoria Island, NWT.

Cow 7771 was the only collared cow to calve and rut on southeast Victoria Island. Since we did see other cows with her, we have tentatively identified a third calving ground based on cow 7771. We subsequently grouped the data from the collared cows into these three possible groups.

The northwest herd (cows 7761, 7764, 7765 and 17760) calved and rutted north of Minto Inlet. The south-central herd calved in south-central and southwest Victoria Island and rutted on the south central coast (cows 7762, 7763, 7766, 7767, 7768, 7769, 17762 and 17768). When we collared cow 7771 north of Cambridge Bay we thought she was on the eastern edge of the caribou wintering to the west. Subsequently her calving and rutting locations suggested that she belonged to a different herd which we have termed 'eastern'.

Seasonal movements: Mean total monthly distances traveled differed between herds and years (Table 1, Appendix A). The lowest rate of monthly movements occurred in December, January, February and March and the highest monthly rates varied but were highest for either pre-calving or pre-rut (May-June, August-October). The total monthly distances traveled by the south-central and northwest herds were significantly different ($H=14.7$, $P=0.02$, 6 d.f.; Mann-Whitney Rank Sum test). Monthly distances moved by cow 7771, who used the southeast part of the island, were not significantly different from the south-central herd ($H=8.9$, $P=0.06$, 4 d.f. Mann-Whitney Rank Sum test).

The correlation between activity indices and distances moved was positive for only 4 of 13 cows ($P<0.05$, activity index and distance tended to increase together) (Appendix B).

The eight cows in the south-central herd did not differ significantly from each other in the total monthly distances traveled from April to March ($H=12.1$, $P=0.096$, 7 d.f. Kruskal Wallis Oneway ANOVA), in either 1987/88 or 1988/89 (Appendix A). The same held true for the group of cows that calved on the

Table 1. **Monthly movements (mean ± Standard Error, km) for satellite-collared cows in the northwest, south-central and eastern herds, 1987-89, Victoria Island.**

Year Group	Month											
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
1987												
NW (n=2)	-	-	-	18.9±4.5	81.6± 15.2	42.4± 13.5	57.1± 4.4	63.3± 12.2	33.6± 7.3	29.7± 2.5	26.4± 4.1	13.6± 4.5
SC (n=6)	-	-	-	32.0± 7.7	54.6± 14.5	117.0± 16.5	86.8± 18.4	86.9± 9.3	108.1± 35.1	58.3± 7.0	66.4± 11.7	17.6± 5.1
East (n=1)	-	-	-	-	-	-	-	-	-	-	-	-
1988												
NW (n=2)	23.9±6.5	22.1± 4.5	15.2± 8.0	(n=4) 32.2± 18.0	73.8± 12.4	77.2±25.7	54.6± 4.7	53.1± 19.5	40.6± 3.9	42.6± 10.1	47.6± 14.2	33.6± 9.6
SC (n=6)	34.9± 8.7	24.2± 4.8	16.9± 6.0	38.8± 10.6	62.5± 12.6	121.4± 23.6	50.8± 9.0	51.2± 23.6	40.7± 7.1	69.1± 21.1	80.3± 25.9	37.4± 16.3
East (n=1)	-	-	-	27.5	106	40.8	45.4	43.6	42.1	80.0	51.7	46.2
1989												
NW (n=4)	18.8± 5.2	19.6± 3.7	20.7± 1.1	22.7± 6.4	-	-	-	-	-	-	-	-
SC (n=6)	25.6± 5.0	18.2± 2.7	23.9± 12.0	58.1± 33.1	41.4 ± 10.3	79.6	-	-	-	-	-	-
East (n=1)	83.7	28.2	82.0	30.9	102.6	70.7	90.7	-	-	-	-	-

northwest part of the island. The total monthly movements for the northwest herd, from April 1988 to April 1989, did not significantly differ between individuals (H=3.8, P=0.29, 3 d.f. Kruskal Wallis Oneway ANOVA) and they moved similar straight line distances between April and December 1988.

The mean total annual distance for cows 7761 and 7765 north of Minto Inlet was 454 ± 7.8 (S.E.) km and for cows 7762 and 7763 on Wollaston Peninsula was 481.5 ± 30.0 (S.E.) km. The four cows collared (7766 - 7769) on central Victoria Island traveled further to their calving and summer areas and their mean total distance covered was 792.6 ± 110.9 (S.E.) km (Table 2).

Table 2. Total annual distance moved by each cow based on 12 months of location data, except where indicated*.

geographic location	Cow #	total annual km moved
northwest	7761	453
northwest	7762	473
northwest	7763	549
northwest	7764	561
northwest	7765	415
s.central	7766*	682
s.central	7767	728
s.central	7768	903
s.central	7769	798
eastern	7771	804
northwest	17760*	612
s.central	17762	464
s.central	17768	451

*9 months of location data

Within the herds, the movements of individual cows were correlated based on annual movements from their calving site during a 12 month period (April-March). The correlation was positive for all cows except cows 17768 and 7768 whose movements only correlated to one or two other cows (Pearson Product Moment correlation (Appendix C). With the exception of those two cows, the northwest and south-central groups of cows were also positively correlated within their groups. Cow 7771, which used the eastern portion of the island, was positively correlated in its annual movements with all other cows except 7768 and 17768.

Annual distances traveled from calving locations were compared using the Kruskal-Wallis ANOVA on ranks. Within the northwest group, there were no significant differences in distances traveled from calving locations (H=3.3, P=0.20, 2 d.f.), except for cow 17760, which traveled further than the rest to calve on the northern tip of the island in 1988. Movement of this cow tested was similar to cow 7767 who used the south central part of the island. Cows 7769, 7768, and 7766 tested similar in their movements from calving locations (H=1.3, P=0.53, 2 d.f.).

Winter distribution: The distances traveled and the extent of single direction movements decreased after October, although some cows continued to travel in November (Appendix A, D). In late October and early November, six of the cows were in the vicinity of their April capture sites (Figure 2 and 14). Cows 7769 and 7762 had moved to the south and south west coast, respectively. Cow 7767 crossed Dease Strait to Jameson Islands where she remained until January (Appendix D). By December all of the cows were within 20km of the coast (Figure 15). Movements during winter months were relatively short (Table 1, Figures 6, 7, 8, 15).

Pre-calving movements: In 1987 and 1988, the mean duration of the pre-calving period was 15 days (Tables 3 and 4) although daily distances and direction traveled varied between individual cows (Appendix F). Cows that moved less than 110 km tended to initiate pre-calving movement after 1 June (3 of 4 cows).

Cows that had further to travel (>110 km) tended to start earlier (before 1 June: 3 of 4 cows).

Table 3. Pre-calving movement by collared cows on Victoria Island, 1987.

Cow #	Pre-calving period	year	No. days	Distance (km)
Northwest group				
7761	May 24 – June 5	1987	13	100.1
7765	May 23 – June 12	1987	20	97.7
South-central group				
7762	May 26 – June 15	1987	21	76.1
7763	June 6 - 9	1987	4	41.4
7766	May 21- June 12	1987	23	182.5
7767	June 1 - 16	1987	16	179.2
7768	June 1 - 16	1987	17	146.0
7769	May 30 – June 11	1987	13	84.3

Table 4. Pre-calving movement by collared cows on Victoria Island, 1988.

Cow #	Pre-calving period	year	No. days	Distance (km)
Northwest group				
7761	May 22 – June 10	1988	20	111.8
7764	May 23 – June 2	1988	11	123.4
7765	May 28 – June 17	1988	21	121.1
17760	June 4 – June 16	1988	13	152.7
South-central group				
7763	June 1 - 16	1988	17	80.4
7767	May 30 – June 12	1988	14	179.2
7769	June 2 - 16	1988	15	112.4
17762	May 28 – June 12	1988	16	72.5
17768	May 31 – June 12	1988	13	145.7
Eastern cow				
7771	May 30 – June 8	1988	10	117.3
7771	May 26 – June 9	1989	15	169.4

1987 Calving Observations

Visual checks of the collared cows during June 1987 (Table 5) indicated calving between 5 and 21 June for the six cows seen with calves. In 1987, four calves had bent backs and hocks, and unsteady legs when first seen (7761, 7763, 7766 and 7762). Three cows markedly increased distance traveled and long-term activity until the morning of the day when we saw the newborn calf. The mean daily distance traveled on the 3 days preceding the day when we saw a newborn calf was 9.8 ± 6.5 km (S.E.). The mean distance for the day when we saw the newborn calf and the two subsequent days was 3.7 ± 1.6 km (S.E.).

Table 5. Calving status of collared cows in June 1987, Victoria Island, NWT

cow	June 3	5	6	8	10	14	16	17	21
7761		new calf		calf					calf, no antlers
7762	hard antlers		hard antlers		hard antlers				new antlers
7763	hard antlers		hard antlers		new calf				
7764									
7765		no antlers[1]							calf, no antlers
7766			hard antlers		new calf			calf, no antlers	
7767			hard antlers		hard antlers	hard antlers	hard antlers		calf, no antlers
7768			hard antlers					hard antlers	
7769							lost calf? no antlers		

---

[1] Either we mistakenly thought she had shed her antlers or we missed seeing the calf.

Cow 7768 likely calved as she showed similar movements to cows with calves, but we did not see her after 17 June, 1987. On 17 June, she still had hard antlers and her subsequent decrease in movements suggests that she may have calved later that day. Likewise, cow 7769 may have calved on 9 June as her daily distance and long-term activity abruptly declined and stayed low for 3 days. When we saw her on 14 June, she had shed her antlers but no calf was seen.

Two cows (7762 and 7763*)* calved on higher ground (300 m agl) inland on Wolleston Peninsula. Cow 7767 calved on the coast and the other five cows calved on the central low-lying area. The weather was unseasonably cool and windy with frequent snow and cloudy days.

1988 Calving Observations

We checked each cow only once in June 1988 (Table 6). Between 13 and 18 June we saw five collared cows with calves and one cow had an enlarged udder but no calf. Only one cow (with a calf) still had hard antlers and all the calves looked older than a few hours (able to walk and trot) but not conspicuously large so we gauged them to be no more than a few days old.

Table 6. Calving status of collared cows in June 1988 seen during aerial surveys, Victoria Island, NWT

cow	13 June	16 June	17 June	18 June
7760				Antlerless, calf
7761				Antlerless, calf
7762			Antlerless	
7763	Antlerless			
7764				Antlered, calf
7765				Antierless, calf
7766				No signal
7767			Antlerless, udder	
7768		Antlerless		
7769		Antlerless		
7771			Antlerless, calf	

Location data collected daily during calving (May 20 - June 20) was used to measure distances moved (Appendix E). The mean distances calculated for each group were not significantly different between the northwest and south-central groups (Table 7) (t=-0.36, P=0.72, 16 d.f). Because we only had data for one cow using the eastern portion of the island, we did not did not include her in our analysis. Although cows in the northwest group all used the northwest part of the island for individual movements, cow 17760 moved a greater distance to the northern tip of the island to calve (Figure 4). The total distance that this cow moved was significantly higher than the other cows in this group (Table 7). The group mean distance moved for the other four cows in the NW group (149.6± 12.5) was not significantly different than the group mean for the south-central group. (P=0.44, t=0.86, 15 d.f.).

Table 7. Total distance moved during calving period, May 20 - June 20, 1987-89.

Northwest group			South-central group			Eastern cow		
Cow#	year	km	Cow#	year	km	Cow#	year	km
7761	1987	123.5	7762	1987	106.0	7771	1988	150.5
7761	1988	134.1	7763	1987	93.6	7771	1989	217.9
7764	1988	197.9	7763	1988	108.0			
7765	1987	143.1	7766	1987	186.3			
7765	1988	144.6	7767	1987	219.9			
17760	1988	215.8	7767	1988	228.7			
			7767	1989	135.4			
			7768	1987	187.0			
			7769	1987	200.7			
			7769	1988	193.8			
			17762	1988	127.3			
			17768	1988	233.8			
Group mean distance			Group mean distance			Group mean distance		
159.8 ± 15.4 (S.E.) *149.6± 12.5 (S.E.)			168.4 ± 14.8 (S.E.)			184.2 ± 33.7 (S.E.)		

*mean calculated without 17760, which calved further north than the rest of this group.

1987 June Aerial Survey Of Calving Distribution

We started the transect aerial survey on 8 June but delayed continuing the survey as the cows were still travelling. Poor weather further delayed us until 15 June, 1987. The total flying time of 84 h included 8 h of ferry time from Norman Wells to Kugluktuk return and 25 h to check calving status of satellite-tracked cows. Weather conditions that influence conspicuousness of caribou were generally poor during the surveys with overcast to patchy cloud and snowcover of 40-90%.

We flew 1,601 km on transect and counted 652 caribou and 94 newborn calves on west-central Victoria Island between 8 and 19 June 1987 (Figure 16, Appendix G). We surveyed the area 30 km west of cow 7762 and continued east to cover central Wollaston Peninsula. We continued the transects east towards the locations of cows 7766, 7767 and 7768. East of Cow 7768, we had to break off lines to the north that were in low cloud. The low cloud prevented us from determining the northern and eastern edge of the calving ground but cows were sparse on the eastern transects. Densities were low (<1 caribou/km^2) and we did not calculate an estimate as the calving ground boundaries were incompletely determined.

We counted 37 caribou and 14 calves on the 477 km of transect on northwest Victoria Island on 21 June 1987 (Table 8). East of Dean Dundas Bay and north of Minto Inlet, we flew north-south transects from the coast toward cow 7761. To determine the eastern boundary of the calving area toward cow 7769, we oriented the transects east-west. The survey coverage was 6%. Patches of low cloud and fog caused us to drop lines 8, 14, 16 and 18 and, as the emphasis was on delimiting the extent of calving, we did not wait and re-fly the area (Figure 16).

The weather during the survey was scattered to patchy cloud. On low ground the snow was half gone leaving patches and snow banks. On elevations above 300 m, the snow cover was almost complete.

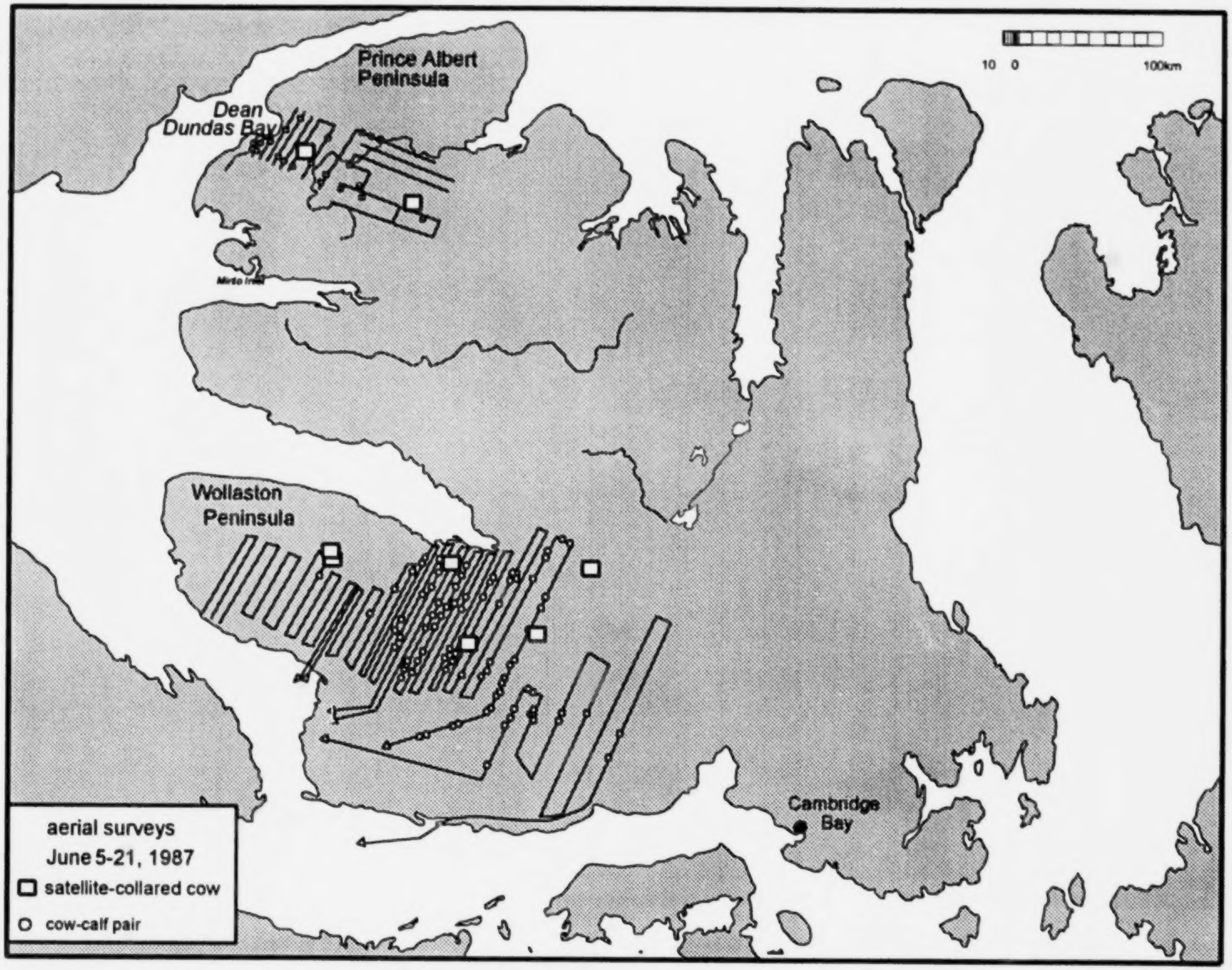

10 0 100km
Prince Albert Peninsula
Dean Dundas Bay
Minto Inlet
Wollaston Peninsula
Cambridge Bay
aerial surveys
June 5-21, 1987
▢ satellite-collared cow
○ cow-calf pair

Figure 16. Flight lines and cow-calf observations during aerial surveys, June 1987, south-central and northwest Victoria Island, NWT.

Mean group size was 2.1± 0.3 (S.E.) and the proportion of calves to total caribou was 27%. The caribou were distributed inland from Dean Dundas Bay in a continuous belt approximately 100 km west to east and 50 km north to south. The north and south extent of the calving area was not delimited as fog and shortage of hours prevented north-south extensions of the transects.

Table 8. Caribou observed on transect during an aerial survey of northwest Victoria Island, NWT, 21 June 1987.

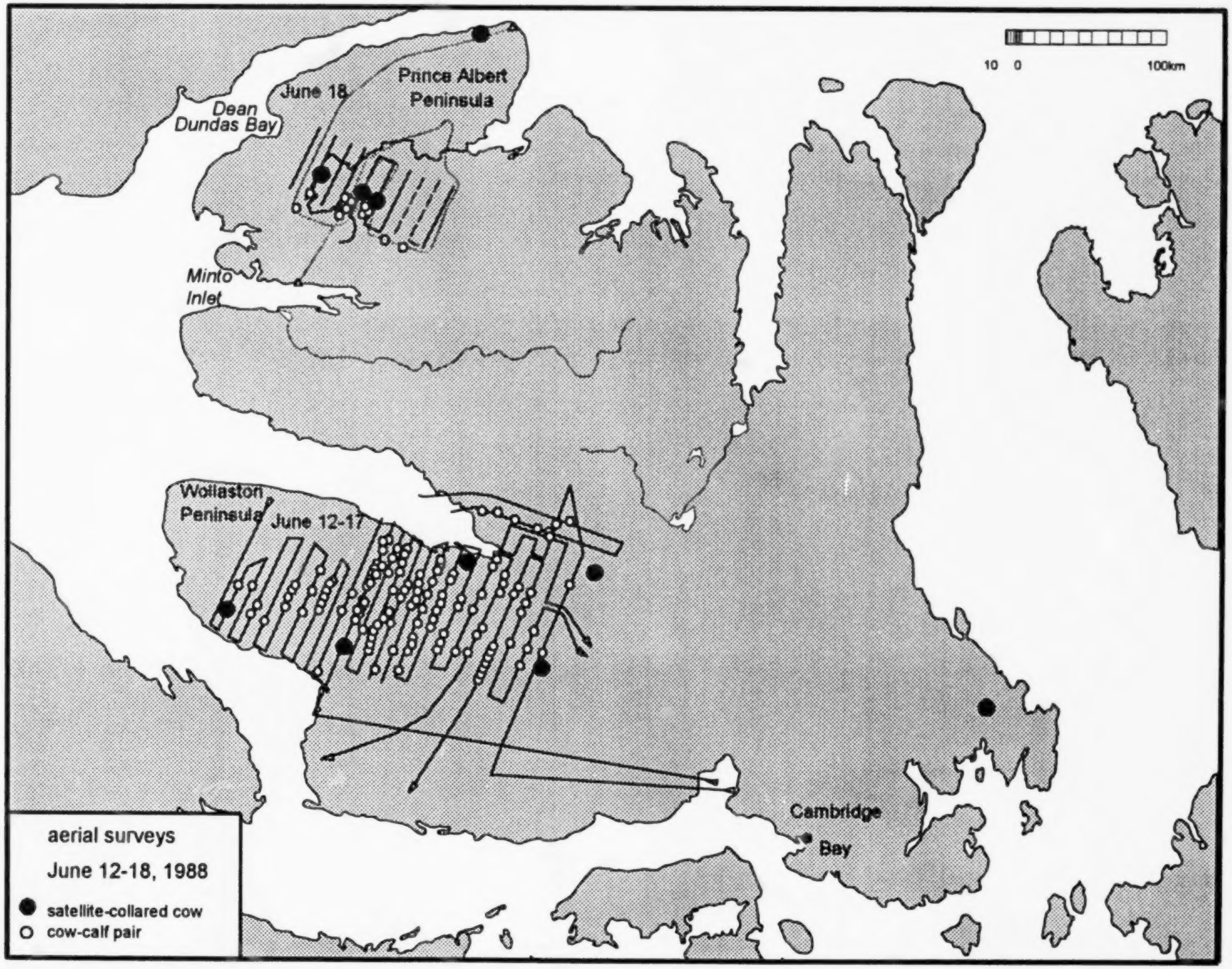
Transect No.	Transect Area km^2	Caribou on transect	calves on transect	Caribou off transect
1	10.4	1		4
2	12.0	6		1
3	14.4	1		0
4	40.0	5		0
5	40.0	2	1	0
6	40.0	6	2	2
7	40.0	1		0
9	40.0	7	6	4
11	28.8	5	2	0
13	28.8	0		5
15	22.4	2	2	0
17	80.0	1	1	0
19	80.0	0		0
Totals	476.8	37 + 14	14	11

1988 June Aerial Survey of Calving Distribution

We mapped the distribution of calving during north-south transects flown between 12 and 18 June 1988 (Figure 17). Our total flying time included 9 h of ferrying between Norman Wells, Holman and Kugluktuk and 57 h for the survey and locating the collared cows.

We flew 2155 km on transect and counted 805 caribou and 203 calves (Appendix G) on west-central Victoria Island, covering an area similar to 1987 but extending further south and to the northeast. However, no calving was seen to the southeast toward the coast. The calf:caribou ratios suggest that calving was underway by 12 June, 1988 (Table 10).

We counted 33 caribou and 17 calves during the survey of northwest Victoria but we aborted the survey after 2 transects because of fog and a shortage of hours. An earlier attempt on 11 June had been postponed because of fog and the survey of the Prince Albert Sound calving area had taken more hours than anticipated. We could not calculate an estimate as only two transects were completed. The coverage was too sparse to describe distribution. Three of the radio-collared cows calved southwest of Richard Collinson Inlet and the fourth radio-collared cow calved at the north end of Prince Albert Peninsula. We did not determine if there was any concentration of caribou in the vicinity of Dean Dundas Bay as in 1987. While checking cow 7765, we saw another cow-calf pair within about 1 km of her. Cow 7764 was with another cow-calf pair and 9 cows with 4 calves were in the immediate vicinity. Cow 7761 was with an antlered cow and Cow 17760, who was further north on the coast, had another cow-calf pair in the vicinity.



10 0 100km
Prince Albert Peninsula
June 18
Dean Dundas Bay
Minto Inlet
Wollaston Peninsula
June 12-17
Cambridge Bay
aerial surveys
June 12-18, 1988
● satellite-collared cow
○ cow-calf pair

Figure 17. Flight lines and cow-calf observations during aerial surveys, June 1988, south-central and northwest Victoria Island, NWT.

Table 9. Caribou, calves and calf to 100 caribou ratio from caribou counted on transect during aerial surveys, June 1987 and 1988, south-central Victoria Island.

	Caribou	Calves	Calf:100 caribou
1987 8 June	39	1	3
15 June	114	15	13
16 June	116	27	23
17 June	178	33	19
19 June	205	71	35
1988 12 June	96	26	27
13 June	173	46	27
14 June	275	69	25
15 June	194	42	22
16 June	67	9	13

Aggregated Calving

The first step in determining whether the cows aggregated for calving was to compare the locations of satellite collared cows with the mapped distribution of calving cows (Figures 16 and 17). The first criterion of aggregation was that satellite-collared cows would calve in the vicinity of other cows. We arbitrarily defined this as 5 cow-calf pairs or breeding cows (cows with hard antlers or uddered cows with or without hard antlers) within 2 km of the collared cow.

In 1987, collared cows 7762 and 7763 were on the northwest margin and within the area covered by the transects, as were cows 7766 and 7767 (Figure 16). Cows 7769 and 7768 were about 20 km east of the surveyed area. Cow 7769 may have lost her calf after 5 June and continued moving north. Cow 7768 was also on the northern boundary and was late calving (after 17 June). The two cows on the northwest calving ground were both within the area surveyed with calving cows (Figure 16).

In 1987, no cows were solitary on all occasions seen during calving (all breeding collared cows had other breeding cows within 2 km of them) although some cows were solitary on one of the occasions seen (Table 10). On three of the fourteen occasions that we saw the collared cows, we did not see any other caribou in their immediate vicinity but each of those cows had been with other caribou on previous or subsequent occasions (Table 10). However, on all except one occasion, the number of breeding cows within 2 km was less than our arbitrary choice of five cows.

Table 10. Calving status and presence of other caribou for satellite-collared cows, June 1987, Victoria Island, NWT.

Cow #	June 3-10			June 11-18			June 19-21		
	Status	Cows <2 km	Others < 2 km	Status	Cows <2 km	Others < 2 km	Status	Cows <2 km	Others < 2 km
7761	calf	4	3	not seen	-	-	calf	6	0
7762	hard antlers	2	0	not seen	-	-	calf	0	0
7763	calf	2	12	not seen	-	-	not seen	-	-
7765	no antlers	2	1	not seen	-	-	calf	0	0
7766	calf	0	0	calf	1	1	not seen	-	-
7767	hard antlers	2	5	hard antlers	0	1	calf	0	3
7768	hard antlers	0	2	hard antlers	4	1	not seen	-	-
7769	not seen	-	-	no antlers	1	0	not seen	-	-

In June 1988, we only checked the collared cows once and three of ten were solitary (Table 11). Two of the solitary cows had perhaps lost their calves and the third solitary cow was not a breeding cow as she had new antler growth. Although cows 17762, 7767 and 7769 were not seen with other cows, their location was within the areas that we mapped as the southwest calving ground (Figure 17).

Cows 17760, 7764, 7761 and 7765 were seen with other cows but as we did not survey the calving ground, we do not know their distribution relative to the calving ground. Only two cows met the criterion of having a minimum of five breeding cows within 2 km.

Table 11. Calving status and presence of other caribou for satellite-collared cows, June 1988, Victoria Island, NWT.

13 -18 June	Status	Cows <2 km	Others < 2 km
17760	calf	1	0
7761	calf	1	0
17762	no antlers	0	0
7763	no antlers	0	1
7764	calf	10	0
7765	calf	10	0
7767	no antlers	0	0
17768	new antlers	0	1
7769	new antlers	0	0
7771	calf	2	1

The second criterion used to identify calving aggregations is that calving cows are aggregated in areas (calving grounds), separated by areas without breeding cows. Our aerial coverage was insufficient to allow us to document that the areas where we saw calving were separated by areas that did not have breeding cows. The flights did not cover the areas between calving grounds or completely delimit the calving grounds themselves.

In June 1987, our flights over southern and central Victoria Island did not completely bound the calving ground as we saw two cow-calf pairs on the eastern most transect and two pairs on the northern most line. Likewise, in June 1988, we saw cows and calves on the outermost transects on the north, south and east. On northwest Victoria our aerial coverage was also insufficient to bound the calving ground in June 1987. In June 1988, fog prevented us from delimiting the northwest calving ground.

Fidelity To Calving Grounds

Our first criterion for defining fidelity to a site was that a pregnant collared cow returned to her previous year's calving site or within an arbitrary 20 km of that site at the time of calving. The distance between a cow's calving location in 1987 and her calving location in 1988 was available for five cows (Table 12). The first column shows the distance calculated between the two the locations on actual observed calving dates. The other two values resulted from calculating the distance between the cow's locations on the same day for each year using each calving date. Cow 7769 was observed to have calved very close to the same date both years and the distance between calving locations is short. All of the cows, except 7765, returned to calve within 20 km of the previous calving location. It is interesting to note that, although cow 7765 was 24.2 km from her 1987 calving location when she calved in 1988, she was less than 7 km from the 1987 calving location on June 13 1988 (previous calving date).

Table 12. Distances (km) between calving locations between 1987 and 1988 for satellite-collared cows, Victoria Island, NWT.

Cow identity (calving dates)	'87 vs '88 location	Distance between locations on date 1	Distance between locations on date 2
7761 (June 5/87, June 13/88)	7.2 km	11.7 km	9.5 km
7763 (June 8/87, June 3/88)	18.1 km	5.2 km	6.7 km
7765 (June 10/87, June 18/88)	24.2 km	12.8 km	4.4 km
7767 (June 18/87, June 13/88)	2.3 km	35.4 km	2.5 km
7769 (June 9/87, June 9/88)	0.4 km	0 km	0 km

Our second criterion to determine fidelity to calving grounds assumed that annual return to a traditional calving ground during our 2 year study could only be met by overlap between the calving grounds in those 2 years. We arbitrarily set the overlap as at least 60%.

The calving ground on west and central Victoria Island overlapped by more than 60% in 1987 and 1988. However, our inability to determine the boundary of an annual calving ground affects the degree of overlap to an unknown extent.

Herd Definition

The use of traditional calving grounds to define herds would be strengthened if the cows that calved together were also closer together during the rut (October) than they were to cows that calved on other calving grounds. By comparing Figures 4 and 5 we see that cows that calved on the same calving ground also shared the same rutting distribution. The degree of association was measured by pair-wise comparisons of the distance between the collared cows on three dates in June and three dates in October for both years (Appendix H). The results in bold letters show the closest associations between cows. The cows that are shown to use the same general areas of the island (ie. northwest, south-central and east) in Figures 4 and 5 are shown to have minimum distances between them during calving and rut dates.

We chose cows that showed minimum distances at calving and rut (Appendix H), and calculated the distance between them during three days in July and three days in January (Table 13). For some collared cows, we did not have enough location data from January so we used data from December. (Note that within the northwest group, cow 17760 calved further north than the rest of the group and therefore shows more variation in distance between her and the other cows at calving).

Table 13. Mean distances (km) between female caribou showing association during calving, rut, summer and winter.

Northwest group		Distance between cows (km)			
Cow#1	Cow#2	calving	rut	summer	winter
7761	7765	68.4±4.8	81.8±2.5	74.3 ±4.0	90.1 ± 2.1
7761	7764	43.2 ±5.5	40.3 ±4.9	40.3 ±5.4	43.8 ±2.1
7761	17760	74.9 ±35.6	23.0 ±4.2	147.6 ±6.2	15.9 ±1.7
7764	7765	27.4 ±4.7	36.2 ±2.9	39.2 ±5.4	89.0 ±4.1
7764	17760	84.9 ±24.2	34.8 ±0.6	118.5 ±1.6	29.1*
7765	17760	92.3 ±19.2	68.2 ±1.6	117.2 ±1.9	75.1 ±3.2
South central group		Distance between cows (km)			
Cow#1	Cow#2	calving	rut	summer	winter
7762	7763	39.9 ±14.7	55.9 ±2.4	44.8 ±2.1	51.6 ±9.4
7763	17762	64.1 ±1.8	71.6 ±4.3	103.8 ±2.2	146.7 *
7766	7767	37.8 ±6.6	35.5 ±5.7	47.6 ±0.9	80.5 ±1.0
7767	17768	98.2 ±17.0	83.5 ±5.3	152.7 ±5.1	143.3 ±1.5
7769	17768	90.0 ±18.4	43.4 *	189.4 ±7.2	52.7*

*only one location date available

The associated cow pairs within the northwest group show the least distances between them during the rut. For most pairs, distances did not vary much between seasons, except for cow 17760 who was found furthest from the others during the summer season. Movements of the northwest group of collared cows were mostly confined to Prince Albert Peninsula and 17760 calved further north than the other cows within this group.

Three pairs of cows within the south-central group showed greater distances between them during summer and winter than during the calving and rutting seasons.

Suitability of Calving Grounds for Population Estimations

The boundaries of calving grounds were diffuse and the amount of flying was insufficient to delimit the calving grounds, as we were still observing cow-calf pairs on the outermost transect line for two calving grounds in 1987 and one calving ground surveyed in 1988.

Calving took place between at least 5-21 June in 1987 and calf to caribou ratios suggested that most calving occurred after 15 June (Table 9). In 1988, our data from the collared cows were insufficient to determine calving dates. We know only that three calves had been born by 18 June and one calf was born on 17 June. Calf to caribou ratios indicate that when the survey began on 12 June, calving was well underway (Table 9).

Effects of Satellite Collars on the Caribou.

When the collars were first fitted and the cows released, we noticed that two cows bounded and reared, shaking their heads, but then galloped and walked away. We were not able to visually inspect them after release but the satellite data on activity and movements did not suggest any conspicuous problems. We saw collared cows nursing calves on the calving ground and we saw them later in the summer, and could not detect any behavioural responses to the collars.

The collars rubbed the late winter hairs of the animals. The collars on the cows collected in late winter 1989 were relatively loose and the collars rubbed, causing patches of broken hair at the top and base of the neck. In those patches, the hair was worn to a stubble 2-5 mm thick. In Cow 7762, the skin was exposed over an area of about 10 x 2 mm and the edge of the collar had slightly abraded but not penetrated the skin. Cow 7768 also had a patch of bare skin (5 x 2 mm). The late winter hair is easily broken which probably accentuated the effect of the collar. The one cow (7771) collected in summer 1990 had a summer coat and there was no sign of rubbing or wear after wearing the collar for 23 months.

Microscopic examination of the skin from under the collar revealed effects that varied from no lesions with a slight skin thickening (7760, 7763, 7767) to mildly infected patches. Cow 7762 had a slight tissue response where the skin was slightly abraded and Cow 7768 had a few nodules of chronic inflammation although most of the skin was relatively normal (Appendix I).

The collars were fitted to be snug but evidently the stiffness of the belting in the cold ambient temperatures in March 1987 impeded the fitting. Overlapping the ends of the collar created a circular-shaped form rather than the more appropriate pear-shape that results from fastening the collar ends together (M. Ferguson pers. comm.). This probably contributed to the poor fit. The cows, when collected, were markedly thin (Appendix I) except Cow 7771, who was taken in July and had substantial fat reserves. However, annual April collections of cows on southern Victoria revealed that those cows were also thin with no visible fat reserves (A. Gunn, unpubl.data).

We cannot judge whether the collared cows died at a higher rate. Sample sizes are small and we did not collect data to estimate mortality for un-collared cows. Excluding the cow that was shot, three of 9 cows died within a year of being collared. One cow that died in May 1987 was old or at least had heavily worn teeth. Two collared cows died during February 1988 of malnutrition. This was the same winter that Cambridge Bay hunters reported freezing rain in early winter and caribou dying along the coast. We investigated this in August 1988 and found 28 caribou carcasses or skeletons west of Cambridge Bay that we judged were from the preceding winter (Appendix J). Their femurs were either empty or had only a red thread of tissue. Five disassembled skeletons (no skulls) had visible white femoral fat and had probably been shot early in winter and partially left as fox trap bait. One still had trap stakes in its vicinity (D. Komayoak pers. comm).

DISCUSSION

Satellite telemetry enabled us to locate two caribou calving grounds on Victoria Island, and to demonstrate that cows aggregated for calving and had affinity to calving areas for the 2 years of the study. However, the criteria for aggregated calving were not fully met as caribou densities were low. Using our criterion of 5 cows within 2 km of a satellite-collared cow, we would expect a density of 0.5 breeding females/km^2. The criterion was chosen prior to surveying and turned out to be unrealistically high. The cows that aggregated for calving were also closer together for the rut which indicates that there were two herds. The usefulness of locating the calving grounds may not be up to our expectations for developing a survey design as the calving was low density and without well defined spatial boundaries.

Herd Delineation

We used 2-year fidelity as an approximation for traditional calving ground use (traditional infers a learnt behavior passed between generations - Gunn and Miller 1986). Defining caribou herds (populations) based on the annual return of the cows to their traditional calving ground, while expedient, has shortcomings. Firstly, it may not be applicable to all caribou. Caribou and reindeer across the circumpolar arctic occupy a variety of landscapes and cope with differing regional climates. Correspondingly, their ecology reflects different strategies to reduce predation risk and to forage effectively.

Defining populations based on traditional calving grounds is not applicable to caribou that disperse at calving to reduce predation risk (Bergerud 1996). Caribou that disperse at calving include woodland and mountain caribou and may include caribou occupying the mountains of Ellesmere or the glaciated coast of Greenland. The classification of caribou as dispersers or gregarious at calving (Bergerud 1996) does not preclude caribou that can use either strategy depending on the existing environmental conditions (quality). Although we can not point to any documented examples, we should be open to this possibility as our knowledge of caribou increases.

We can expect variation in spatial distribution during calving if distribution depends on forage quantity and quality (as well as predation). Forage quantity and quality exert strong influences and change over time. Given the less predictable start to and the shorter plant growing season (thus lower plant biomass) on the arctic islands compared to the mainland, we predict that calving will be more dispersed than on the mainland and that calving locations may annually vary more on the arctic islands. The low densities that we have observed on Victoria Island support this supposition. Although we recognize that density and dispersion are not the same thing, density is an index to dispersion. Densities, as an index to how caribou disperse relative to forage biomass, are confounded by caribou numbers. The Dolphin and Union herd was likely increasing – hunters at Cambridge Bay were reporting more caribou spreading further south and east during the 1980s. As caribou numbers increase, either their density on the calving ground will increase or the size of the calving ground will increase if forage biomass is limiting densities.

If the degree of calving aggregation and dispersal reflect habitat suitability then it raises the question of how the calving cows evaluate habitat suitability given the brief time spent on the calving ground. A possible mechanism can be surmised from studies of avian dispersal models. Avian dispersal models include evaluation of habitat suitability when the birds lack the time to sample all possible habitats and instead cue on their neighbour's behaviour to select nesting habitat. Danchin *et al.* (1998) tested how conspecific's behaviour influences colonial nesting in the Black-legged Kittiwake *Rissa tridactyla*. The gull's fidelity to their nesting cliffs is not automatic. Rather, individual birds used the average fledging success of their neighbours as a basis for returning or dispersing to a new cliff site the following year (Danchin *et al.* 1998). Failed breeders at poor quality sites abandoned their nest and typically squatted at successful nests in other colonies. This gave the failed breeders cues as to the colony's habitat quality as measured by fledging success at that colony. Prospecting for nesting sites a year before nesting is a known avian behavior for first-time breeders and failed breeders (examples in Danchin *et al.* 1998). The corresponding behavior in caribou would be female yearling cows accompanying their maternal cows to the calving grounds.

Using these results as the basis for a conceptual model of caribou calving strategies would lead to testable predictions based on habitat quality and how caribou assess habitat quality. This approach might explain the diversity in caribou calving strategies as well as predict how strategies may change over time.

A second shortcoming of using traditional calving grounds as the basis for defining caribou populations is that it is an expediency, which only partially meets the conventional population definition. Many definitions for 'population' have been used implicitly or explicitly - for example, Wells and Richmond (1995) list 13 published definitions. Wells and Richmond (1995) recommended that a population be defined as a group of conspecific individuals that is demographically, genetically, or spatially distinct from other groups of individuals. The problem with determining whether caribou are demographically distinct is that we sample demographics on an assumed herd basis so we have no independent measure. Even with these definitions, there is also the key consideration of determining the criteria for 'distinct'.

Genetic distinctness in now more amenable to measurement using DNA analysis although sampling has to be designed to avoid circular arguments. Criteria are needed to establish what constitutes distinctiveness from neighbouring populations and using genetic differences raises the problem of temporal scale. Genetic differences are accumulated at a rate that partially depends on environmental severity but is likely in the order of 100s of years, which represents an average over many population fluctuations.

There is evidence from a variety of sources, including Inuit traditional knowledge (for example, Ferguson and Messier 1996), to support the existence of fluctuations in caribou numbers although whether they are cyclic or not is unclear. Spatial and demographic differences may reflect a time-scale of decades.

Fidelity to a calving ground does meet spatial distinctness as a criterion for a population but that criterion would be strengthened if it correlated with rutting distribution. This is the case for the satellite collared cows on Victoria Island (Figures 4 and 5). Cows found together on two calving grounds were also, on average, closer together in mid-late October than they were to any other congregation.

Our conclusion is that caribou returning to the same traditional calving ground also aggregated together during the rut. This provides the information to meet spatial and, likely, genetic separation as criteria for describing the Minto Inlet and Dolphin and Union herds as separate herds. The herd identity for Cow 7771 is less certain as she showed calving and rutting distribution that was spatially separate from the Dolphin and Union herd (Figures 4 and 5, Appendix D). Hunters' observations suggest that the distribution of caribou was relatively continuous from 7771's rutting area to the south coast.

Subsequent VHF radio-collaring in the 1990s (J. Nishi pers. comm.) supported separate eastern calving but not segregation from the collared Dolphin and Union herd during the rut. Two plausible explanations are: 1) as the caribou increased, the eastern and central caribou overlapped during the rut and have become one herd and 2) separation during the rut based on the one collared cow was flawed by such a small sample size.

Small sample size is a disadvantage especially if a population/herd has sub-structuring either as a result of its history (reduction in numbers to form remnant sub-populations) or as a consequence of the relationship between habitat heterogeneity and fitness (for example Oriens and Wittenberger 1991) operating along a gradient insufficient to cause population structure.

Which tools we use to describe population structure and relationships depends on the questions being asked and their time scale. Satellite telemetry has the potential to evaluate population structure due to the ease with which calving and rutting fidelity can be measured. It is a short-term technique and measures population structure over a brief time period, but is useful for immediate questions such as survey design and effect of harvests. Over a time scale of 100s or 1000s of years, analysis of genetic variation through nuclear and mitochondrial DNA would be the tools of choice, respectively.

Estimating Herd Size From Calving Ground Surveys

One of our objectives was to determine if caribou on Victoria Island calve gregariously and annually in the same area. If they were using a traditional calving ground, this might allow the application of calving ground surveys to estimate the number of breeding females and extrapolate that to population size (Heard 1985). Our results indicate that the cows were annually calving on the same area during the 2-year study and the areas overlapped with those documented during a subsequent radio-tracking study in the early 1990s (Nishi In Prep.).

If calving is spread over more than a few days, cows with calves will already be leaving the calving ground before other cows have calved. This would increase the size of the area to be surveyed. It would also impede defining the boundaries of a calving ground, as low densities of calving cows make it more difficult to determine the boundaries for the calving area. The ability to precisely define the boundary is important because estimating abundance on the calving ground depends on extrapolating from the area surveyed. A calving ground survey was attempted in 1994 and ran into the same difficulty in defining the limits of the calving ground (Nishi In Prep.). Additionally, the difficulties that we had with weather in June 1987 and 1988 are typical of the weather on Victoria Island as the snow starts to melt. Poor weather in June may be a frequent factor limiting the effectiveness of calving surveys.

Another difficulty with calving surveys is that the timing of the peak of calving is likely more variable at higher latitudes, which makes timing of the survey less predictable. For example, in the western High Arctic on Bathurst Island, calving annually varies from early June to early July (Miller 1988). In the spring of 1987, calving was 2 - 3 weeks late, taking place between 5 - 21 June with a peak about 19 June, based on calf-cow ratios. Although we had fewer observations in 1988, we estimate that calving had peaked by the time our survey started on 12 June. The data from the collared cows (Table 13) are too few to compare timing of calving between 1987 and 1988.

Basing a survey technique on calving grounds has to build in a contingency for the dynamic nature of calving grounds. If rising caribou numbers increase the size of the calving ground, then that relationship would reduce the usefulness of the calving ground as a survey area. Additionally, as data have been collected over decades, changes in the area used for calving have been documented at least for the mainland herds of barren-ground caribou. Those changes have tended to be directional shifts in the overlap of annual calving grounds and may be characterized as rotational over decades (Sutherland and Gunn 1996, Gunn and Sutherland 1997). Defining calving grounds using only a few year's data may be misleading if the rotational shifts seen on the barren-ground caribou calving grounds are a characteristic of calving grounds elsewhere.

Winter and Summer Distribution and Range Overlap

The caribou herd using ranges north of Minto Inlet remained separate from the range of Dolphin-Union herd (including southwest central Victoria Island) but whether this is always the case is questionable. The Minto Inlet herd was declining and its range had likely contracted. Subsequently, the decline accelerated and by 1993, the herd had dwindled to less than 100 caribou (Gunn. In Press).

The most likely overlap between the two herds is postcalving distribution. The Dolphin and Union cows that calved in central Victoria Island moved north after calving and by August were close to the Kuujjua River (Figures 1 and 7) at the southern edge of the Shaler Mountains. The Minto Inlet herd collared cows reached the northern edge of the Shaler Mountains by August, suggesting that overlap is a possibility, especially if either or both herds were to increase in size. Possible overlap in July and August distribution will be a factor in designing future surveys, as it would be difficult to reliably distinguish between caribou from the two herds from survey altitude.

Overlap between the two herds in winter is unlikely at present because, since the late 1980s, the Dolphin-Union herd's winter range along Victoria Island's south coast has changed to wintering on the mainland (one cow, 7767, had already spearheaded this change by wintering on the Jameson Islands during this study). By the mid-1990s, thousands of Dolphin-Union caribou were wintering along the mainland coast (Gunn *et al.* 1997). A shift in winter range is characteristic of caribou and may be related to forage availability. Conventionally, lichens are identified as the key winter forage but that depends on geographic location. Lichens are relatively uncommon on southern Victoria Island (S. Edlund pers. comm.) due to the underlying geology. The Dolphin-Union caribou were feeding mainly on the dwarf shrub *Dryas* in late winter but also on willow *Salix* spp. and dry upland sedges *Carex spp.* (Gunn unpubl. data).

Given the difficulty of surveying during calving and the possible overlap in July-August distribution between the two herds, an alternate method is to survey during the rut using collared caribou to locate the rutting caribou. This is facilitated for the Dolphin and Union herd as the rut coincides with caribou staging along the coast as the caribou wait for the sea-ice to freeze so they can migrate to the mainland. In 1987-89, the collared cows wintered along the coast and only one collared cow migrated to the mainland for the winter. Subsequently, the size of the fall migration to the mainland has increased (Gunn *et al.* 1997) and a subsequent radio-collar study further documented the coastal distribution of rutting caribou (J. Nishi pers. comm.). In October 1997, an aerial survey during the rut estimated 28 000 along the south coast (Nishi and Gunn. In Prep.).

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Appendix A. **Monthly total distances (km) moved by collared cows, 1987-89, Victoria Island, NWT.**

Month	7761	7762	7763	7764	7765	7766
1987						
April	14.4	20.9	36.2	-	23.4	22.0
May	96.8	27.3	22.2	-	66.4	113.3
June	28.9	75.2	75.6	-	55.9	140.5
July	52.7	33.6	78.7	-	61.4	83.6
Aug.	75.4	74.5	68.5	-	51.1	72.9
Sept.	26.3	52.1	78.1	-	40.8	88.5
Oct.	32.2	45.3	42.8	-	27.2	82.5
Nov.	30.4	47.3	47.1	-	22.3	71.9
Dec.	9.10	11.0	24.8	-	18.0	6.5
1988						
Jan.	30.4	57.0	16.8	-	17.5	-
Feb.	26.5	28.8	21.3	-	17.6	-
March	29.8	-	36.8	-	13.5	-
April	5.9	-	34.1	28.8	10.0	-
May	83.9	-	28.7	104.1	54.2	-
June	37.9	-	104.5	41.1	81.3	-
July	47.8	-	50.2	68.6	50.5	-
Aug.	31.1	-	24.4	33.2	36.5	-
Sept.	37.8	-	41.0	50.7	41.7	-
Oct.	64.4	-	61.9	40.2	16.2	-
Nov.	31.6	-	140.0	78.7	16.7	-
Dec.	16.0	-	25.0	50.4	49.8	-
1989						
Jan.	-	-	11.9	22.7	25.1	-
Feb.	12.9	-	21.6	20.3	25.7	-
March	-	-	22.5	21.8	19.6	-
April	-	-	37.8	29.1	16.4	-
May	-	-	11.7	12.3	4.8	-

Month	7767	7768	7769	7771	17760	17762	17768
1987							
April	18.9	25.4	68.6	-	-	-	-
May	39.4	44.1	81.4	-	-	-	-
June	175.0	98.2	137.5	-	-	-	-
July	113.9	159.4	51.8	-	-	-	-
Aug.	108.8	74.5	122.4	-	-	-	-
Sept.	60.5	281.0	88.2	-	-	-	-
Oct.	45.3	75.4	58.4	-	-	-	-
Nov.	114.9	37.8	79.4	-	-	-	-
Dec.	7.9	38.9	16.3	-	-	-	-
1988							
Jan.	17.1	53.9	29.5	-	-	-	-
Feb.	16.0	14.3	40.6	-	-	-	-
March	9.8	-	24.3	-	2.2	4.9	8.7
April	78.0	-	40.8	27.5	84.1	21.9	19.3
May	76.0	-	101.1	106.0	53.0	43.7	62.8
June	162.4	-	147.4	40.8	148.3	36.4	156.5
July	83.9	-	43.7	45.4	51.6	46.3	29.9
Aug.	55.1	-	141.4	43.6	111.4	16.2	19.0
Sept.	55.7	-	54.7	42.1	32.0	16.9	35.2
Oct.	127.7	-	1.3	80.0	49.8	95.3	59.4
Nov.	129.0	-	33.3	51.7	63.3	90.5	8.6
Dec.	3.7	-	44.4	46.2	18.1	96.9	17.0
1989							
Jan.	34.2	-	31.6	83.7	8.50	-	24.6
Feb.	23.7	-	12.7	28.2	-	-	14.7
March	-	-	45.3	82.0	-	-	3.9
April	156.5	-	22.8	30.9	-	-	15.4
May	49.4	-	45.5	102.6	-	-	59.0
June	79.6	-	-	70.7	-	-	-
July	-	-	-	90.7	-	-	-
Aug.	-	-	-	20.9	-	-	-
Sept.	-	-	-	63.6	-	-	-
Oct.	-	-	-	87.1	-	-	-
Nov.	-	-	-	84.6	-	-	-

Appendix B. **Correlation of activity indices vs. distance travelled for all locations during study using Pearson Product Moment test.**

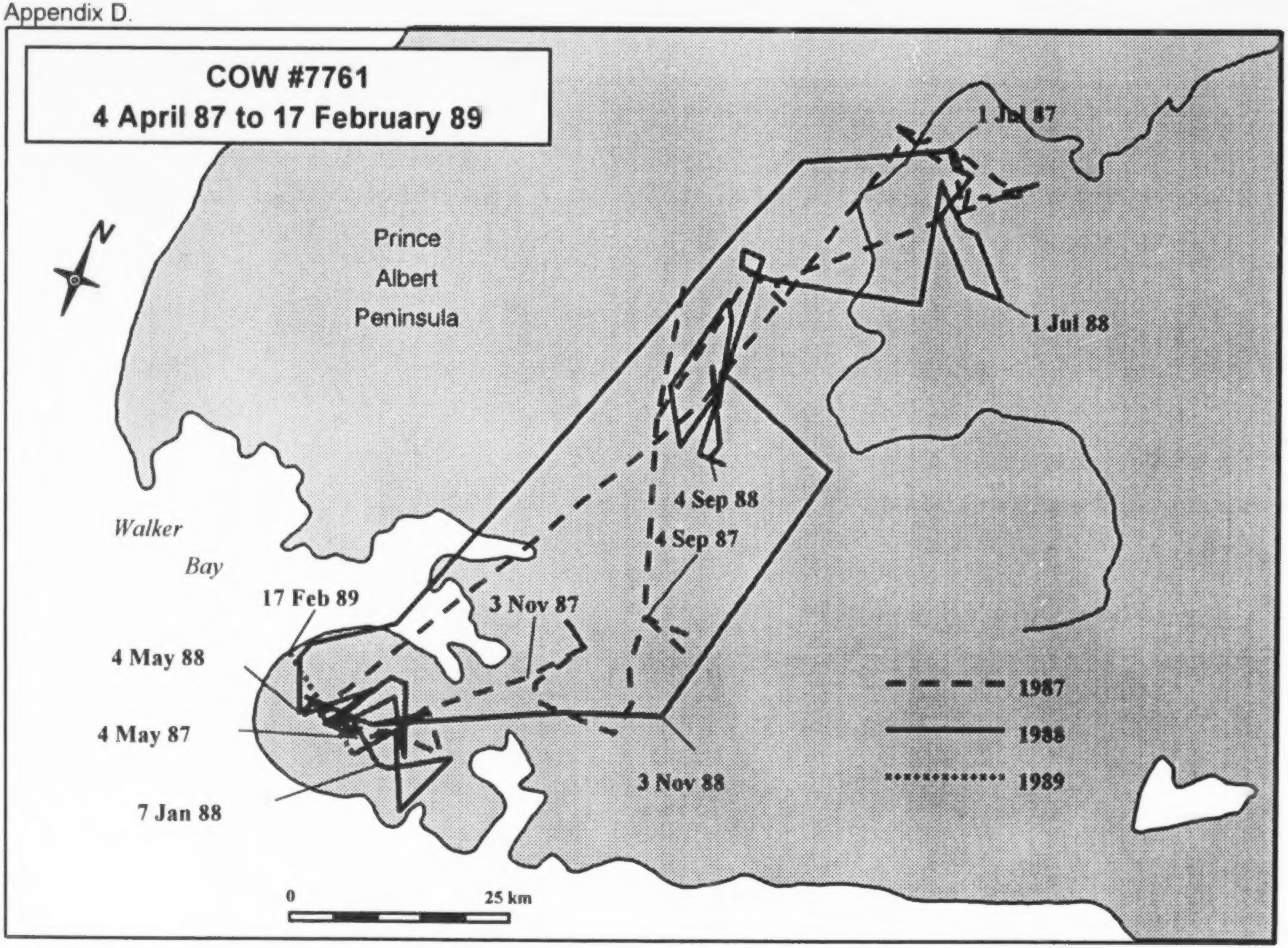
cow #	Correlation Coefficient	P value	n
7761	0.175	0.07	109
7762	0.022	0.88	55
7763	0.120	0.16	155
7764	0.312	0.004*	84
7765	0.347	0.00002*	142
7766	0.110	0.50	40
7767	0.023	0.79	126
7768	0.328	0.015*	54
7769	0.271	0.0021*	126
7771	0.062	0.50	123
160	0.180	0.22	47
162	0.019	0.90	43
168	0.210	0.14	49

*positive correlation, ie. distance moved and activity index tend to increase together.

Appendix C. **Pearson Product Moment correlation test showing positive (+), negative(-) or no (n) correlation in distances moved from the calving site.**

group		7762	7763	7766	7767	7768	7769	17762	17768	7761	7764	7765	17760	7771
SC	7762													
SC	7763	+												
SC	7766	+	+											
SC	7767	+	+	+										
SC	7768	n	n	n	-									
SC	7769	+	+	+	+	-								
SC	17762	+	+	+	+	n	+							
SC	17768	-	-	n	-	+	-	-						
NW	7761	+	n	+	+	-	+	n	n					
NW	7764	+	+	+	+	-	+	-	+	+				
NW	7765	+	+	+	+	-	+	+	-	+	+			
NW	17760	+	+	+	+	n	+	+	n	+	+	+		
East	7771	+	+	+	+	-	+	-	n	+	+	+	+	

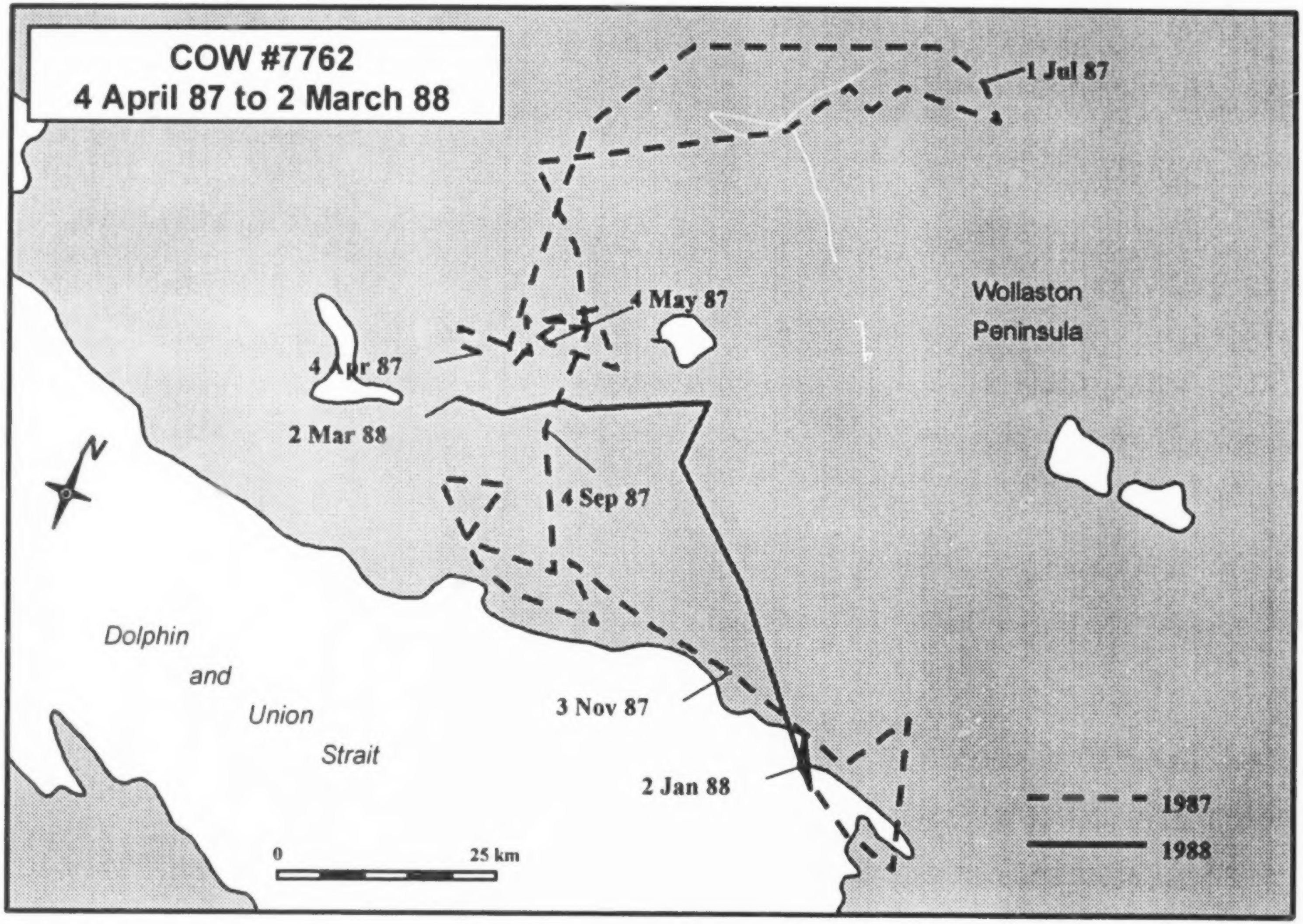
Appendix D.



COW #7761
4 April 87 to 17 February 89

Prince
Albert
Peninsula
Walker
Bay
1 Jul 87
1 Jul 88
4 Sep 88
4 Sep 87
3 Nov 87
3 Nov 88
17 Feb 89
4 May 88
4 May 87
7 Jan 88
1987
1988
1989
0
25 km
N

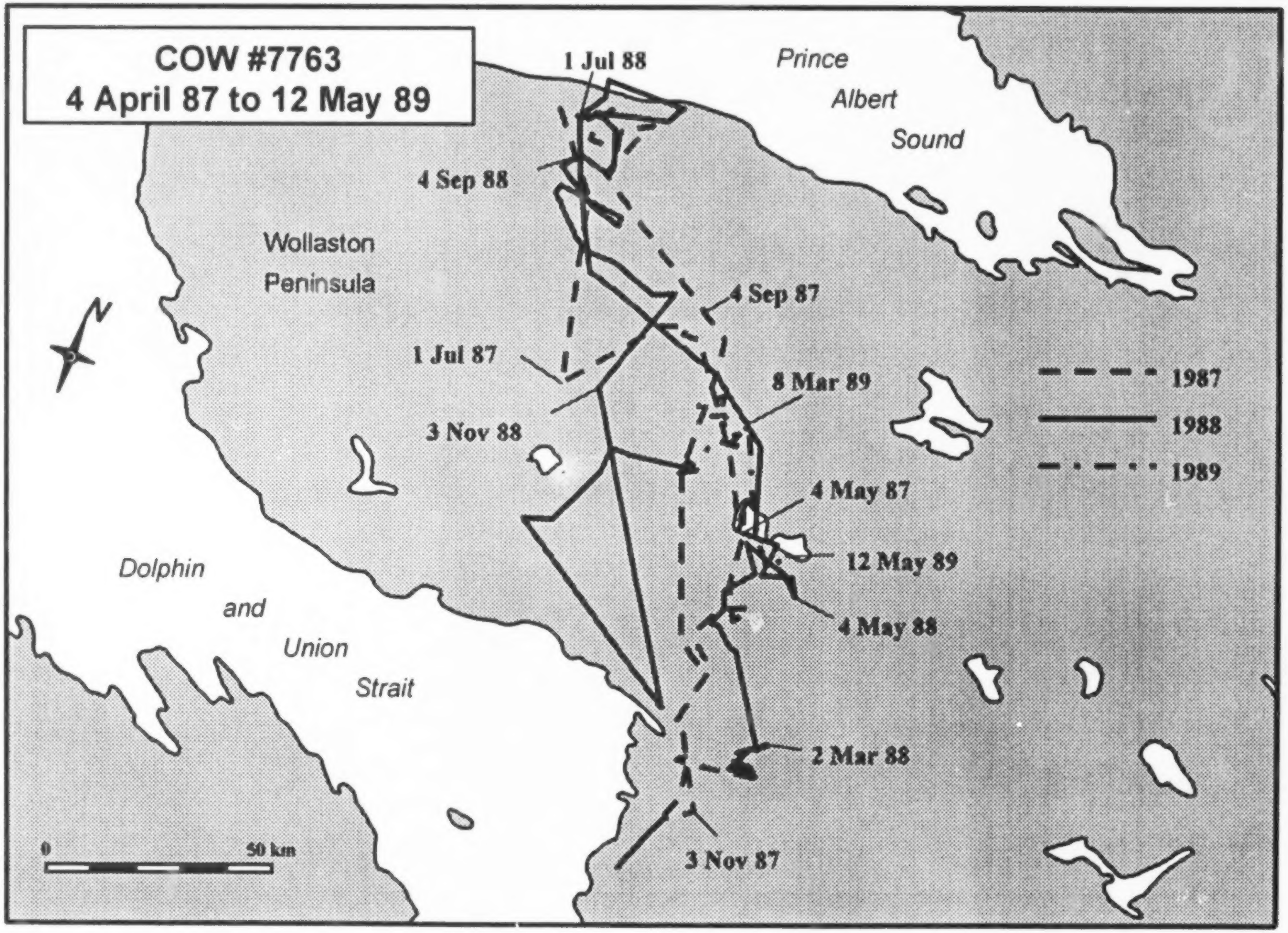
Appendix D.



COW #7762
4 April 87 to 2 March 88

1 Jul 87
4 May 87
4 Apr 87
2 Mar 88
4 Sep 87
3 Nov 87
2 Jan 88
Wollaston
Peninsula
Dolphin
and
Union
Strait
N
0
25 km
1987
1988

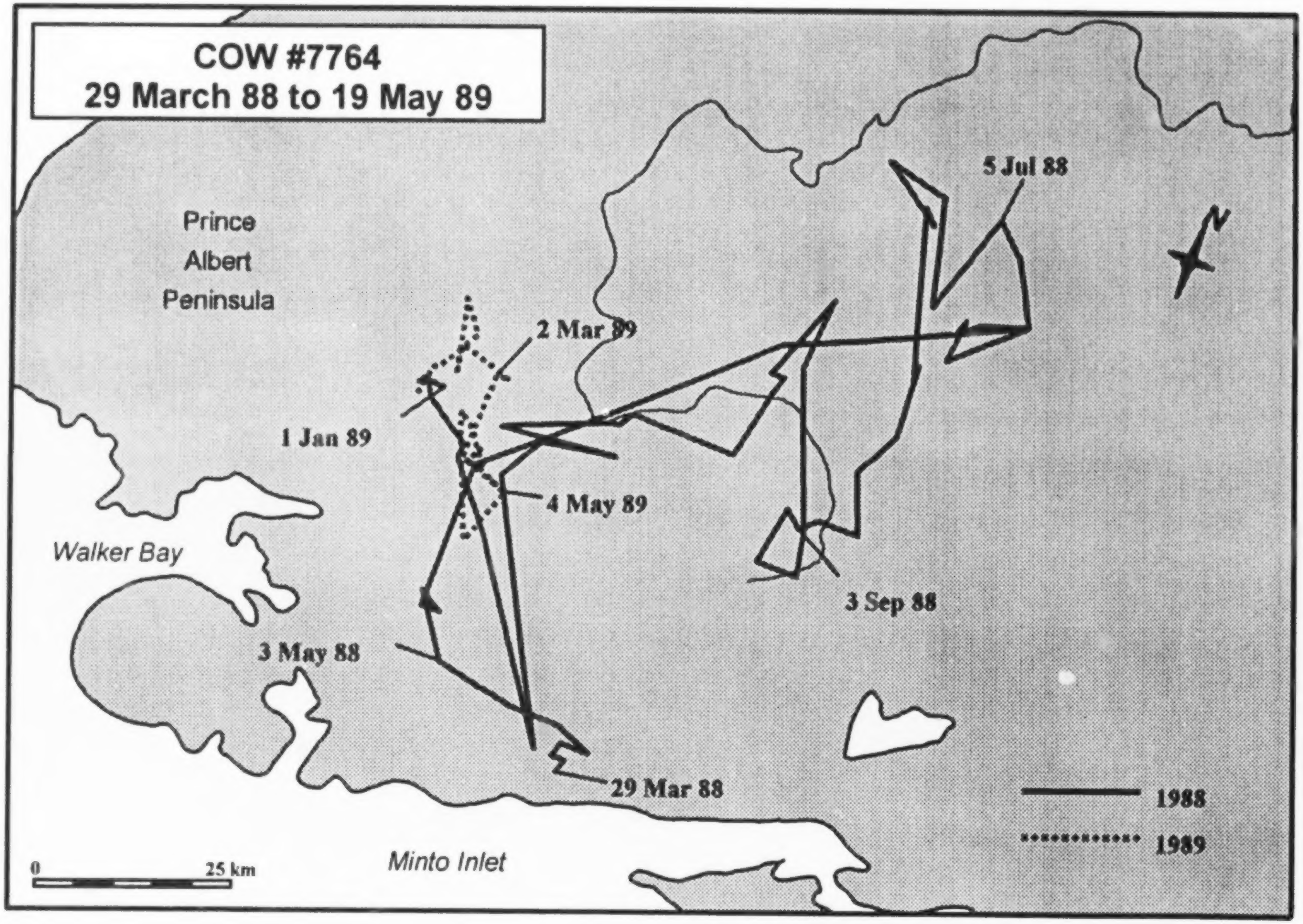
Appendix D.



COW #7763
4 April 87 to 12 May 89

1 Jul 88
Prince
Albert
Sound
4 Sep 88
Wollaston
Peninsula
4 Sep 87
1 Jul 87
8 Mar 89
3 Nov 88
1987
1988
1989
4 May 87
12 May 89
Dolphin
and
Union
Strait
4 May 88
2 Mar 88
0
50 km
3 Nov 87
N

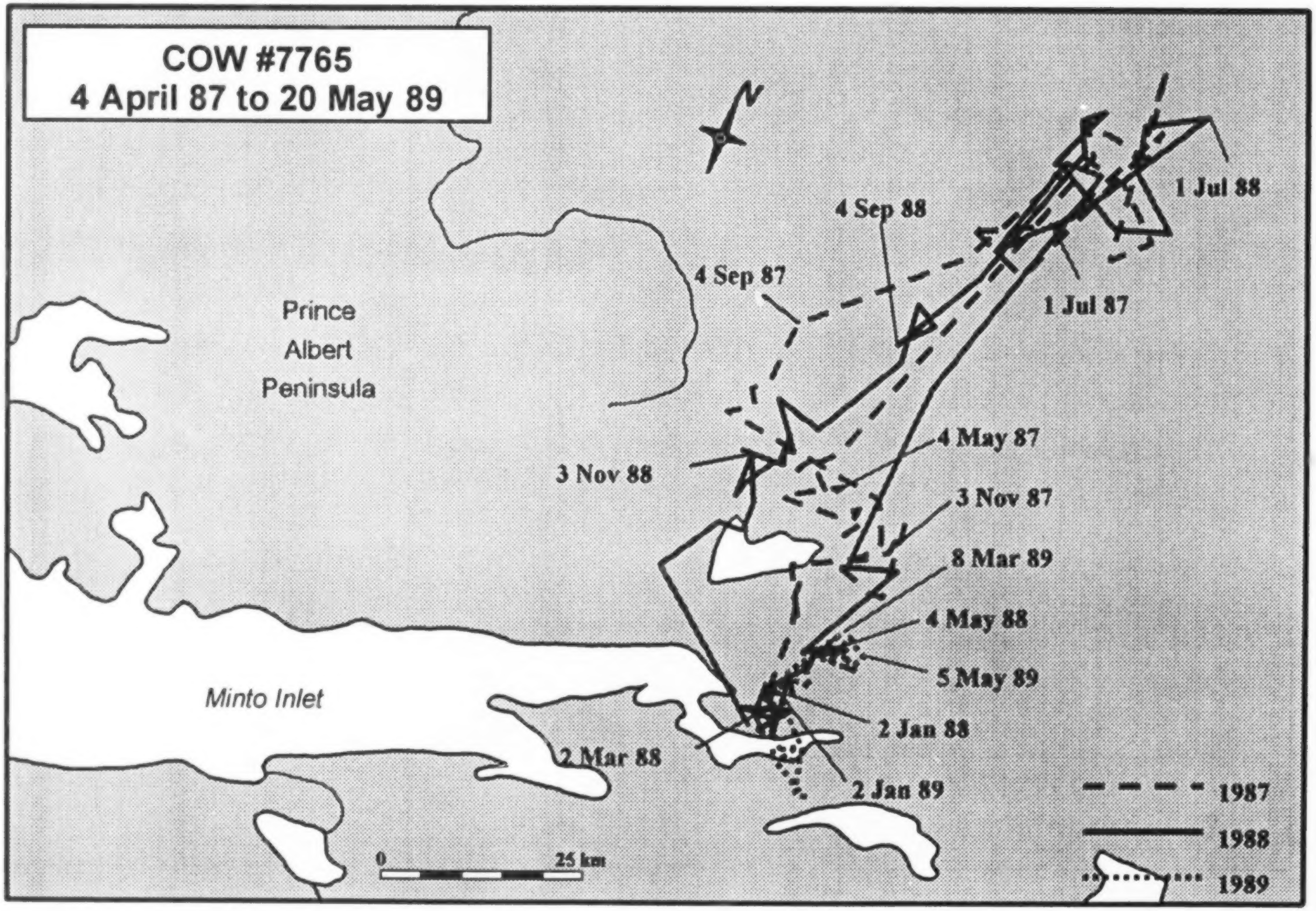
Appendix D.



COW #7764
29 March 88 to 19 May 89

Prince
Albert
Peninsula
Walker Bay
Minto Inlet
1 Jan 89
2 Mar 89
4 May 89
3 May 88
29 Mar 88
3 Sep 88
5 Jul 88
N
1988
1989
0
25 km

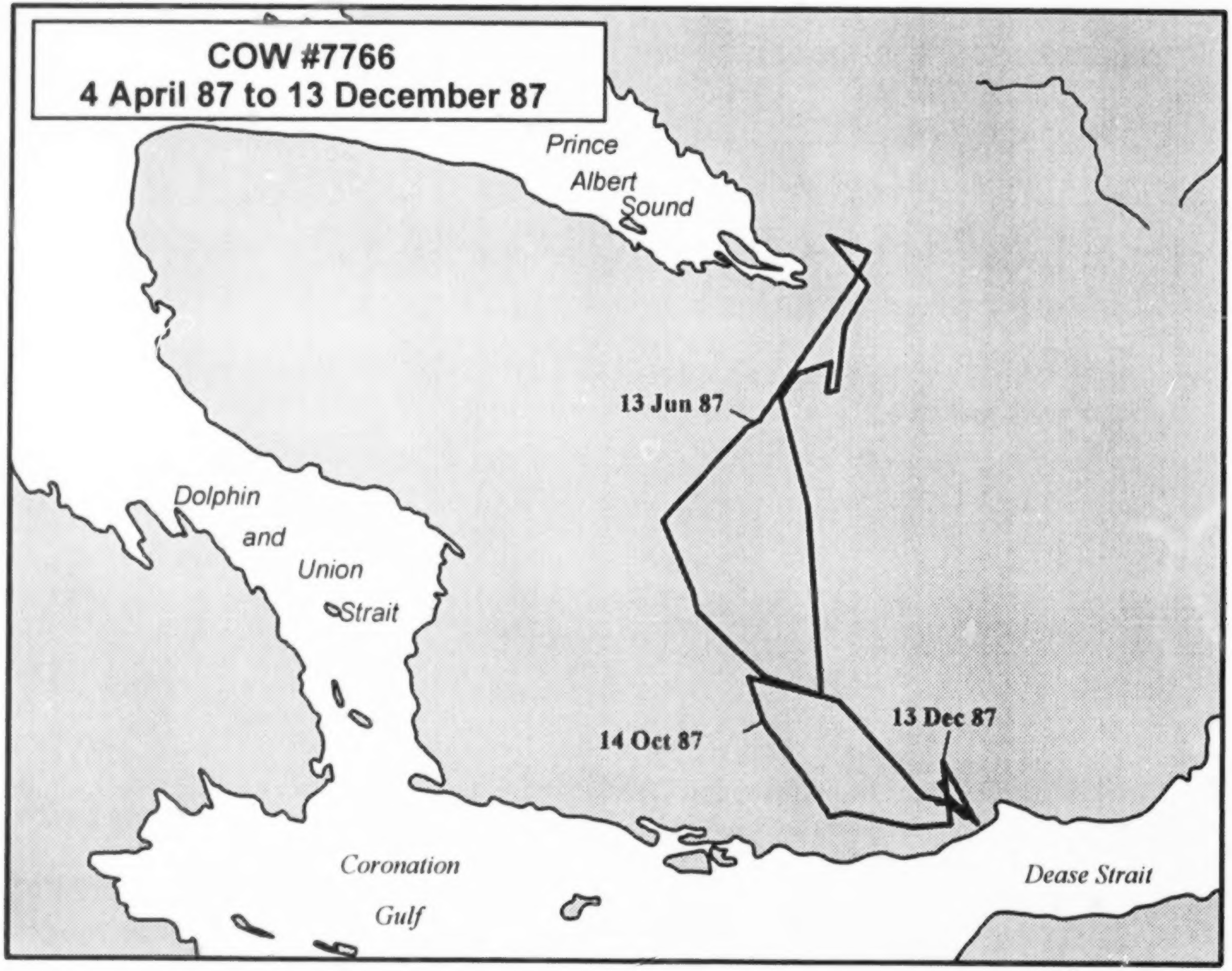
Appendix D.



COW #7765
4 April 87 to 20 May 89

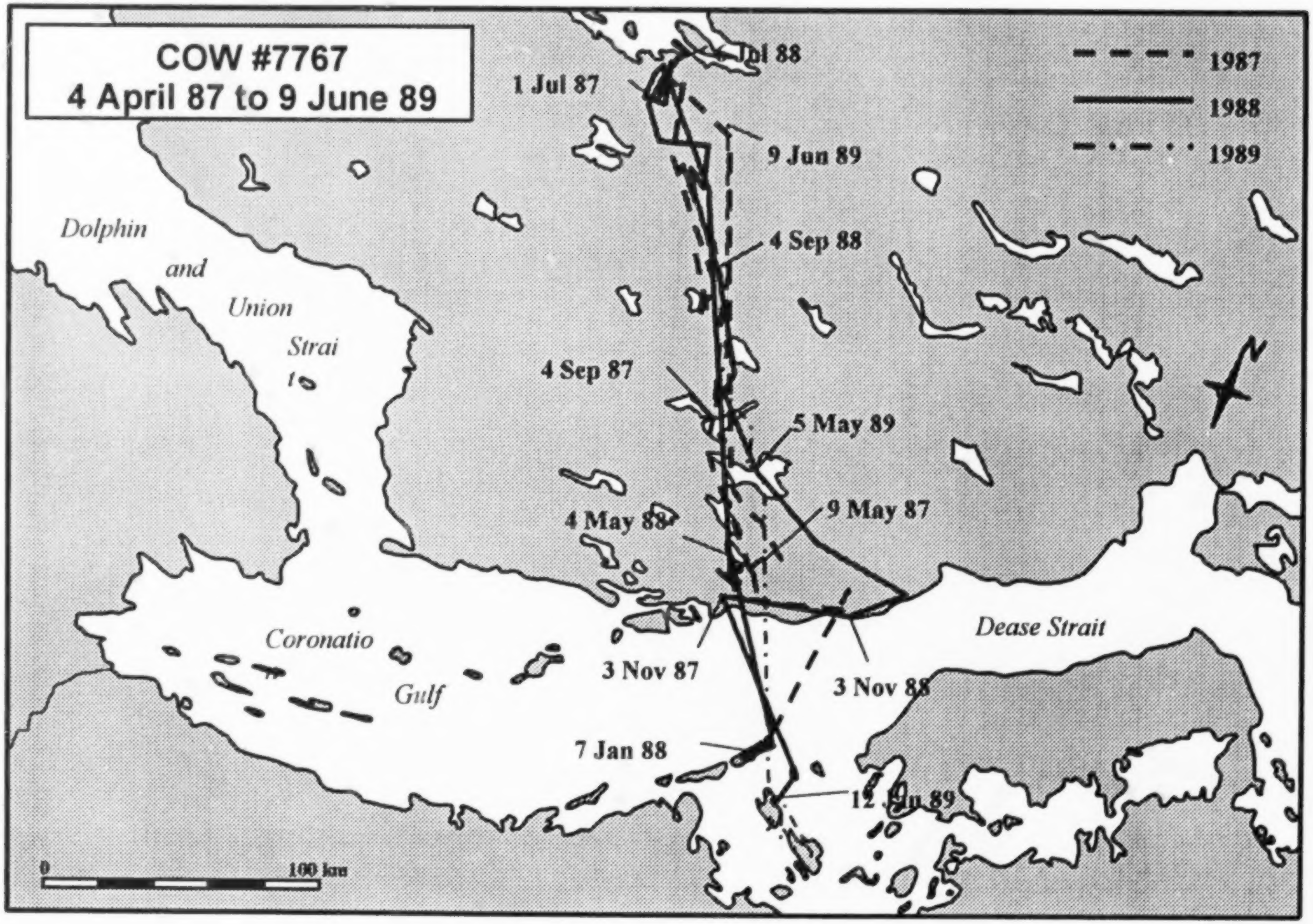
N
Prince Albert Peninsula
Minto Inlet
4 Sep 88
1 Jul 88
4 Sep 87
1 Jul 87
3 Nov 88
4 May 87
3 Nov 87
8 Mar 89
4 May 88
5 May 89
2 Jan 88
2 Mar 88
2 Jan 89
0
25 km
1987
1988
1989

Appendix D.



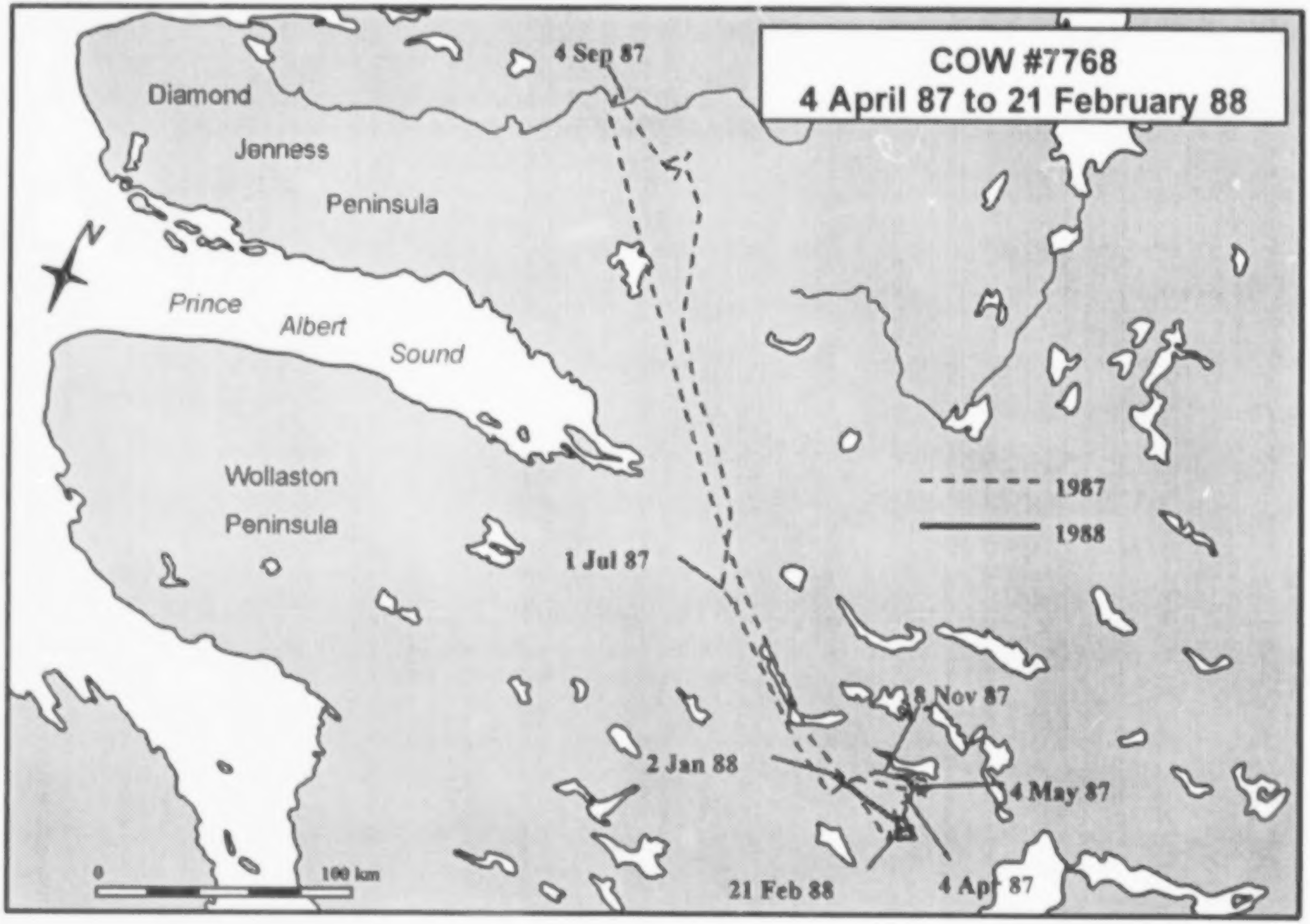
COW #7766
4 April 87 to 13 December 87
Prince
Albert
Sound
13 Jun 87
Dolphin
and
Union
Strait
14 Oct 87
13 Dec 87
Coronation
Gulf
Dease Strait

Appendix D.

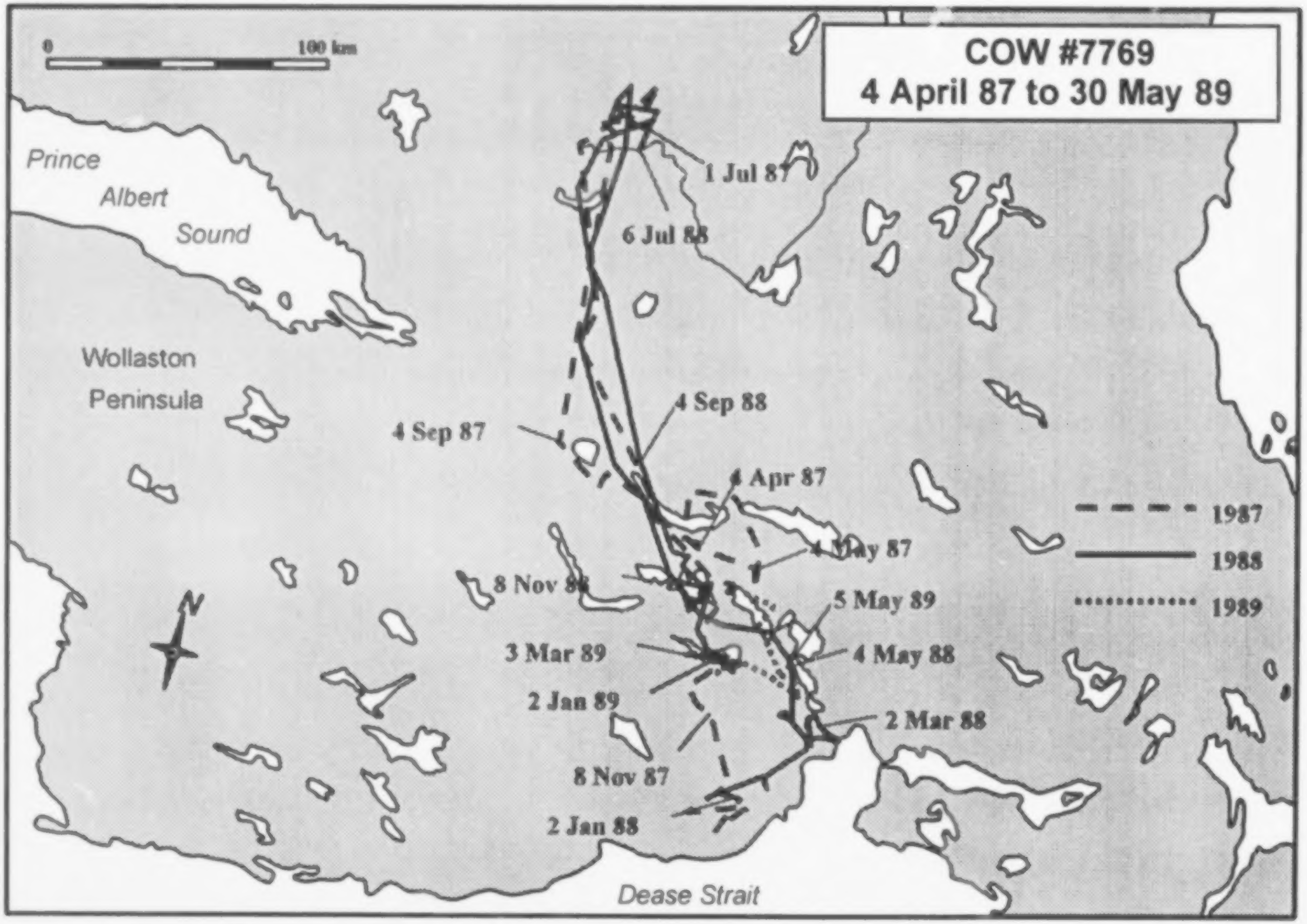


COW #7767
4 April 87 to 9 June 89
1987
1988
1989
Jul 88
1 Jul 87
9 Jun 89
4 Sep 88
4 Sep 87
5 May 89
9 May 87
4 May 88
3 Nov 87
3 Nov 88
7 Jan 88
12 Jun 89
Dolphin and Union Strait
Coronation Gulf
Dease Strait
N
0
100 km

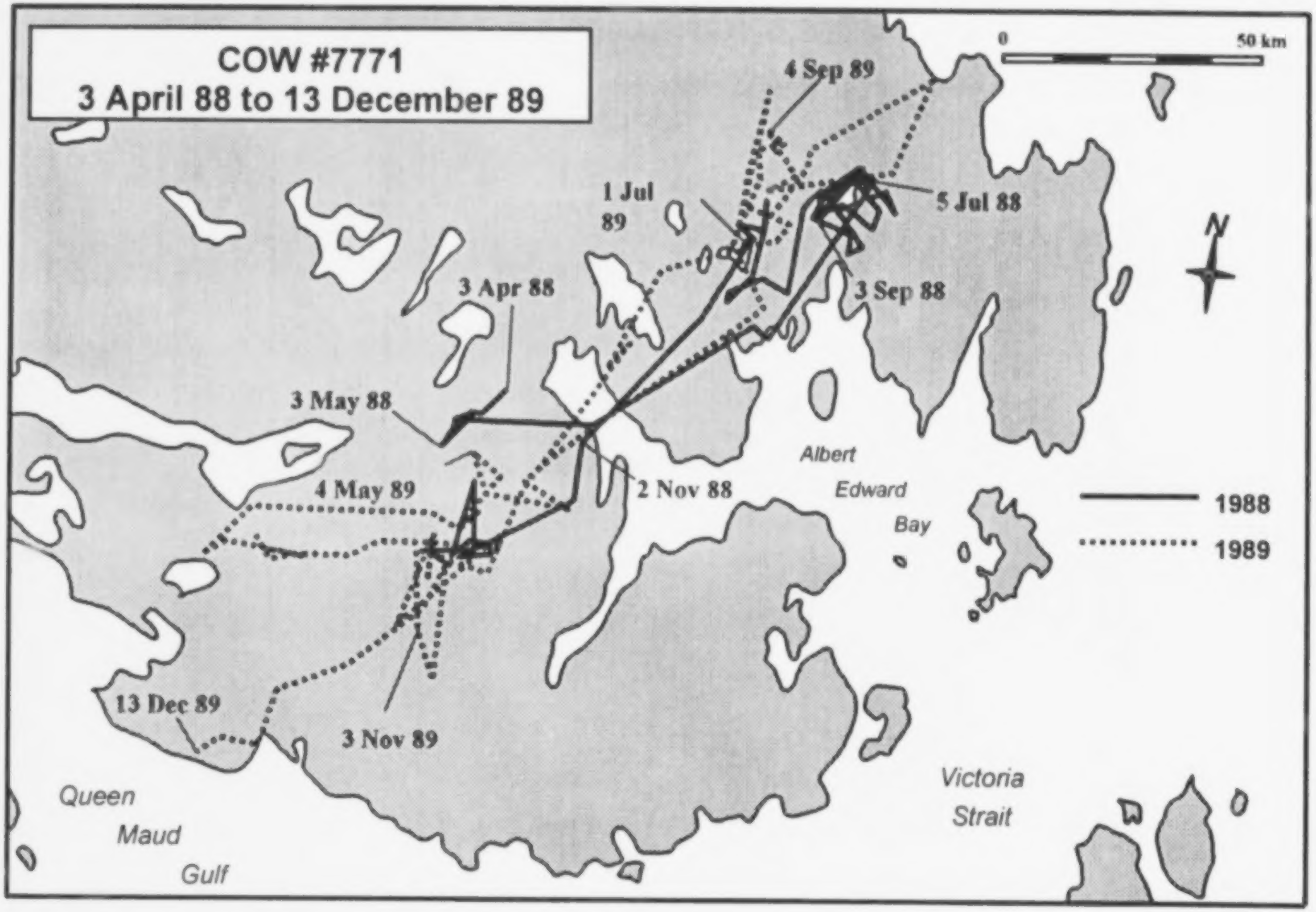
Appendix D.


COW #7768
4 April 87 to 21 February 88
Diamond
Jenness
Peninsula
Prince
Albert
Sound
Wollaston
Peninsula
N
4 Sep 87
1 Jul 87
1987
1988
8 Nov 87
2 Jan 88
4 May 87
21 Feb 88
4 Apr 87
0
100 km

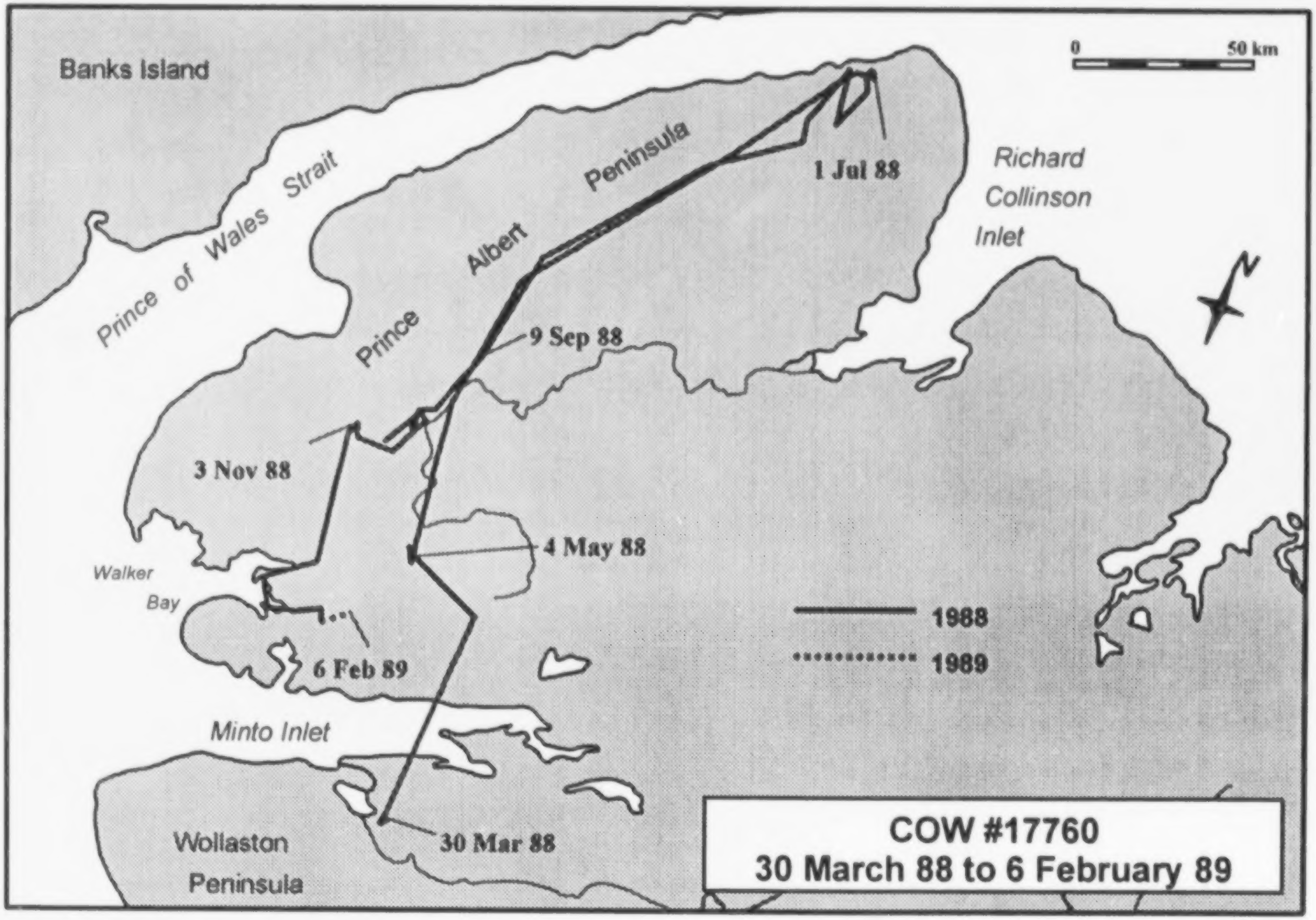
Appendix D.


COW #7769
4 April 87 to 30 May 89
0
100 km
Prince
Albert
Sound
Wollaston
Peninsula
1 Jul 87
6 Jul 88
4 Sep 88
4 Sep 87
4 Apr 87
4 May 87
8 Nov 88
5 May 89
3 Mar 89
4 May 88
2 Jan 89
2 Mar 88
8 Nov 87
2 Jan 88
N
Dease Strait
1987
1988
1989

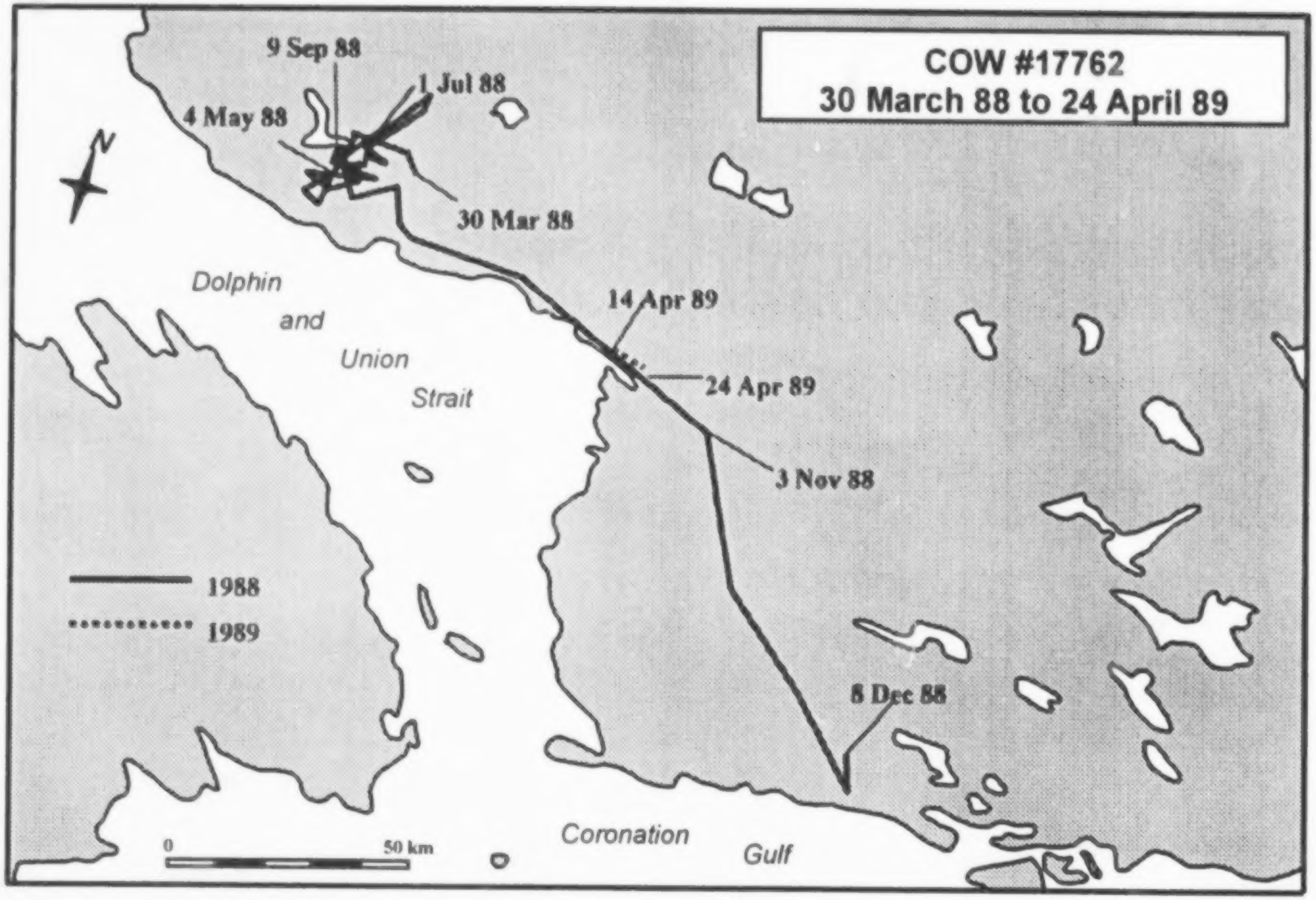
Appendix D.


COW #7771
3 April 88 to 13 December 89
0
50 km
N
1988
1989
4 Sep 89
1 Jul 89
5 Jul 88
3 Sep 88
3 Apr 88
3 May 88
2 Nov 88
4 May 89
13 Dec 89
3 Nov 89
Albert Edward Bay
Victoria Strait
Queen Maud Gulf

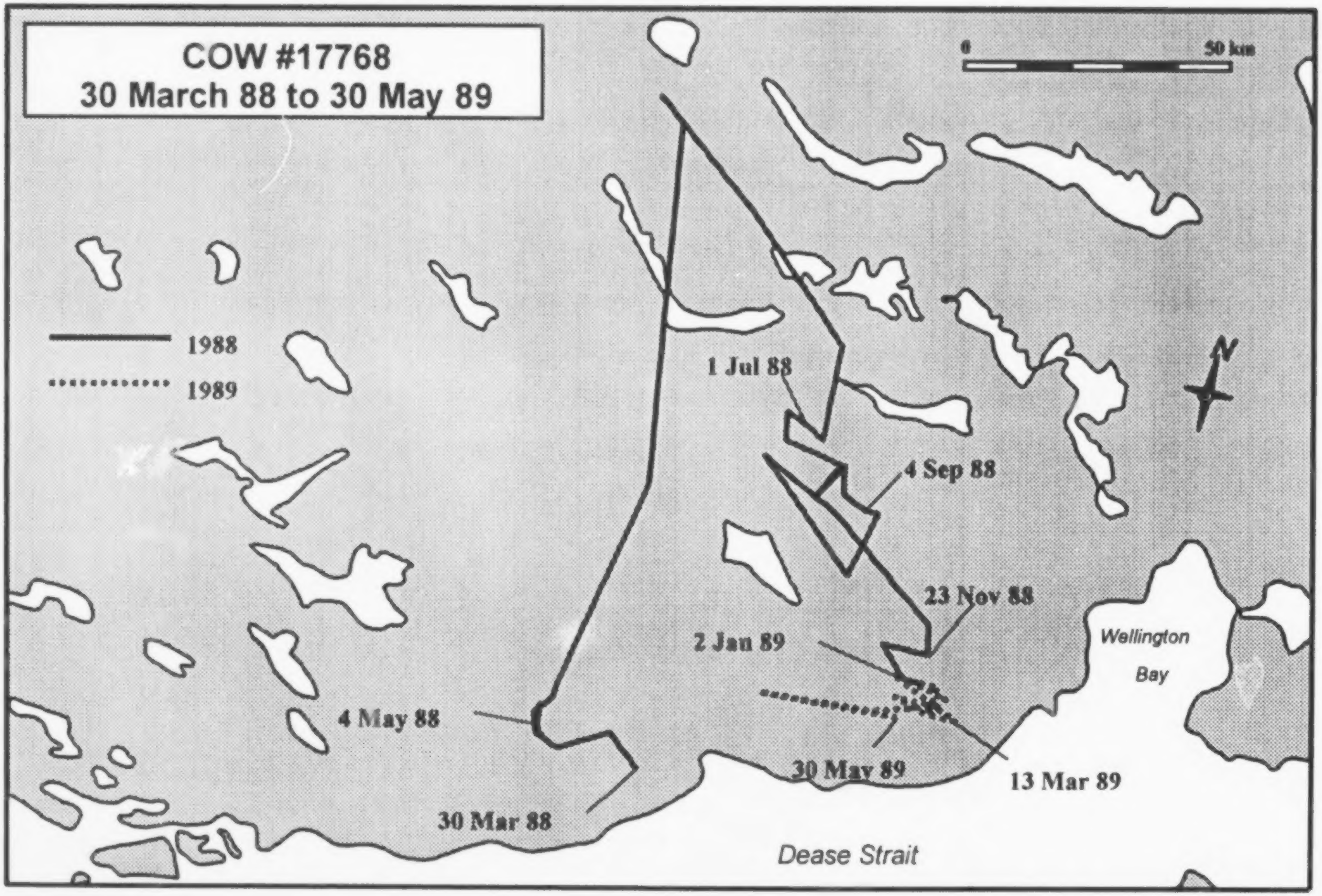
Appendix D.


Banks Island
Prince of Wales Strait
Prince Albert Peninsula
Richard Collinson Inlet
0
50 km
N
1 Jul 88
9 Sep 88
3 Nov 88
4 May 88
Walker Bay
6 Feb 89
Minto Inlet
Wollaston Peninsula
30 Mar 88
1988
1989
COW #17760
30 March 88 to 6 February 89

Appendix D.


COW #17762
30 March 88 to 24 April 89
9 Sep 88
1 Jul 88
4 May 88
30 Mar 88
N
Dolphin
and
Union
Strait
14 Apr 89
24 Apr 89
3 Nov 88
1988
1989
8 Dec 88
0
50 km
Coronation
Gulf

Appendix D.


COW #17768
30 March 88 to 30 May 89
0
50 km
N
1988
1989
1 Jul 88
4 Sep 88
23 Nov 88
2 Jan 89
13 Mar 89
30 May 89
4 May 88
30 Mar 88
Wellington Bay
Dease Strait

Appendix E. **Daily movements between 20 May and 20 June for pre-calving and calving collared cows, 1987-989, Victoria Island, NWT.**

Cow #	month	day	activity	km	year
7761	5	20	30	0.6	1987
7761	5	21	12	1.9	1987
7761	5	22	20	1.8	1987
7761	5	23	28	1.9	1987
7761	5	24	44	5.1	1987
7761	5	25	55	6.0	1987
7761	5	26	183	21.6	1987
7761	5	27	191	18.8	1987
7761	5	28	68	6.9	1987
7761	5	29	83	5.6	1987
7761	5	30	159	16.9	1987
7761	5	31	43	5.7	1987
7761	6	1	66	6.5	1987
7761	6	2	42	2.3	1987
7761	6	3	35	1.9	1987
7761	6	4	-	2.8	1987
7761	6	6	31	0.6	1987
7761	6	7	24	0.6	1987
7761	6	8	19	0.6	1987
7761	6	9	16	1.1	1987
7761	6	10	16	2.8	1987
7761	6	12	12	1.1	1987
7761	6	13	36	3.4	1987
7761	6	14	36	0.6	1987
7761	6	15	26	1.1	1987
7761	6	16	38	4.9	1987
7761	6	17	31	0.6	1987
7761	6	18	27	2.9	1987
7761	6	19	36	1.9	1987
7761	6	20	58	0	1987
7761	5	20	20	2.2	1988
7761	5	21	23	1.9	1988
7761	5	22	270	24.7	1988
7761	5	23	314	24.1	1988
7761	5	24	130	15.2	1988
7761	5	25	60	1.7	1988
7761	5	26	68	8.8	1988
7761	5	27	29	1.7	1988
7761	5	28	48	3.4	1988
7761	5	29	25	2.3	1988

Cow #	month	day	activity	km	year
7761	5	30	23	2.3	1988
7761	5	31	43	2.5	1988
7761	6	1	65	1.9	1988
7761	6	2	56	1.1	1988
7761	6	3	66	6.5	1988
7761	6	4	95	9.8	1988
7761	6	7	30	1.9	1988
7761	6	8	16	2.2	1988
7761	6	9	17	1.7	1988
7761	6	10	21	2.3	1988
7761	6	11	24	0.6	1988
7761	6	12	23	1.7	1988
7761	6	13	16	1.9	1988
7761	6	14	-	0.6	1988
7761	6	16	40	1.9	1988
7761	6	17	40	1.1	1988
7761	6	18	60	5.8	1988
7761	6	19	40	2.3	1988
7761	6	20	57	0	1988
7762	5	20	23	2.0	1987
7762	5	21	36	0	1987
7762	5	22	37	0	1987
7762	5	23	45	0	1987
7762	5	24	40	0	1987
7762	5	25	33	0.6	1987
7762	5	26	33	3.7	1987
7762	5	27	55	3.7	1987
7762	5	28	249	1.9	1987
7762	5	29	114	2.0	1987
7762	5	30	60	2.0	1987
7762	5	31	26	0.6	1987
7762	6	1	50	2.7	1987
7762	6	3	75	5.9	1987
7762	6	4	-	9.3	1987
7762	6	6	80	7.7	1987
7762	6	7	43	4.5	1987
7762	6	8	47	2.0	1987
7762	6	9	41	1.3	1987
7762	6	10	79	9.4	1987
7762	6	11	86	5.1	1987
7762	6	12	45	3.2	1987
7762	6	13	43	4.3	1987
7762	6	14	96	4.2	1987
7762	6	15	42	1.3	1987

Cow #	month	day	activity	km	year
7762	6	16	36	1.9	1987
7762	6	17	174	23	1987
7762	6	19	62	3.7	1987
7762	6	20	38	0	1987
7763	5	20	33	0	1987
7763	5	21	-	0.6	1987
7763	5	22	53	3.9	1987
7763	5	23	47	3.2	1987
7763	5	24	62	2.7	1987
7763	5	25	49	2.0	1987
7763	5	26	43	3.9	1987
7763	5	27	49	0.6	1987
7763	5	28	79	2.0	1987
7763	5	29	66	1.3	1987
7763	5	30	70	4.2	1987
7763	6	1	88	0.6	1987
7763	6	2	76	2.0	1987
7763	6	3	52	3.2	1987
7763	6	6	72	13.4	1987
7763	6	8	130	12.8	1987
7763	6	9	170	10.0	1987
7763	6	10	145	1.9	1987
7763	6	11	128	4.2	1987
7763	6	12	74	2.7	1987
7763	6	13	78	2.2	1987
7763	6	14	99	2.0	1987
7763	6	15	87	2.7	1987
7763	6	16	76	2.7	1987
7763	6	17	87	1.9	1987
7763	6	18	111	3.1	1987
7763	6	19	145	3.8	1987
7763	6	20	82	0	1987
7763	5	20	91	0	1988
7763	5	21	131	4.9	1988
7763	5	22	66	3.2	1988
7763	5	23	40	1.3	1988
7763	5	24	56	0	1988
7763	5	25	83	1.3	1988
7763	5	26	65	0.6	1988
7763	5	27	91	1.3	1988
7763	5	28	54	0	1988
7763	5	29	83	1.3	1988
7763	5	30	96	0	1988
7763	5	31	120	4.9	1988

Cow #	month	day	activity	km	year
7763	6	2	76	3.2	1988
7763	6	3	82	1.9	1988
7763	6	4	75	3.7	1988
7763	6	5	149	5.7	1988
7763	6	6	146	4.9	1988
7763	6	7	110	7.6	1988
7763	6	8	117	2.7	1988
7763	6	9	103	4.5	1988
7763	6	10	119	2.3	1988
7763	6	11	105	9.7	1988
7763	6	12	111	4.5	1988
7763	6	13	154	10.0	1988
7763	6	14	-	5.7	1988
7763	6	16	157	9.1	1988
7763	6	17	76	3.7	1988
7763	6	18	176	3.7	1988
7763	6	19	96	6.3	1988
7763	6	20	121	0	1988
7764	5	23	330	24.8	1988
7764	5	24	338	29.1	1988
7764	5	25	160	11.0	1988
7764	5	26	99	3.8	1988
7764	5	27	109	8.8	1988
7764	5	28	195	11.5	1988
7764	5	29	116	6.8	1988
7764	5	30	204	15.3	1988
7764	5	31	109	3.9	1988
7764	6	1	34	4.1	1988
7764	6	2	105	4.3	1988
7764	6	3	43	1.1	1988
7764	6	4	168	9.3	1988
7764	6	5	169	9.3	1988
7764	6	6	74	2.9	1988
7764	6	7	128	5.4	1988
7764	6	8	120	5.0	1988
7764	6	9	171	10.1	1988
7764	6	10	33	2.9	1988
7764	6	11	124	5.8	1988
7764	6	12	75	5.8	1988
7764	6	13	51	4.1	1988
7764	6	14	-	3.4	1988
7764	6	16	72	3.9	1988
7764	6	17	65	2.5	1988
7764	6	18	59	1.9	1988

Cow #	month	day	activity	km	year
7764	6	19	80	1.1	1988
7764	6	20	170	0	1988
7765	5	20	24	1.9	1987
7765	5	21	35	0	1987
7765	5	22	23	0.6	1987
7765	5	23	35	3.0	1987
7765	5	24	192	17.5	1987
7765	5	25	172	16.3	1987
7765	5	26	106	11.6	1987
7765	5	27	59	1.9	1987
7765	5	28	37	0	1987
7765	5	29	53	1.7	1987
7765	5	30	46	2.8	1987
7765	5	31	43	3.9	1987
7765	6	1	31	3.4	1987
7765	6	2	33	2.5	1987
7765	6	3	38	2.2	1987
7765	6	4	-	6.5	1987
7765	6	6	85	4.1	1987
7765	6	7	76	2.5	1987
7765	6	8	56	1.9	1987
7765	6	9	93	6.2	1987
7765	6	10	104	9.7	1987
7765	6	11	82	2.2	1987
7765	6	12	42	0	1987
7765	6	13	67	4.7	1987
7765	6	14	157	9.3	1987
7765	6	15	130	9.7	1987
7765	6	16	85	3.4	1987
7765	6	17	89	3.9	1987
7765	6	18	66	3.7	1987
7765	6	19	80	6.0	1987
7765	6	20	54	0	1987
7765	5	20	74	2.2	1988
7765	5	21	78	5.8	1988
7765	5	22	38	1.9	1988
7765	5	23	77	2.9	1988
7765	5	24	79	4.4	1988
7765	5	25	24	0.6	1988
7765	5	26	6	0.6	1988
7765	5	27	14	1.2	1988
7765	5	28	21	3.8	1988
7765	5	29	24	6.0	1988
7765	5	30	38	3.7	1988

Cow #	month	day	activity	km	year
7765	5	31	41	1.9	1988
7765	6	1	56	3.8	1988
7765	6	2	258	16.9	1988
7765	6	3	190	15.2	1988
7765	6	4	147	13.2	1988
7765	6	7	134	5.4	1988
7765	6	8	90	5.6	1988
7765	6	9	125	6.2	1988
7765	6	10	143	1.1	1988
7765	6	11	82	9.2	1988
7765	6	12	57	5.7	1988
7765	6	13	97	5.6	1988
7765	6	14	-	8.7	1988
7765	6	15	59	1.1	1988
7765	6	16	48	5.1	1988
7765	6	17	43	2.9	1988
7765	6	18	47	0	1988
7765	6	19	14	3.9	1988
7765	6	20	24	0	1988
7765	5	20	36	0	1989
7766	5	21	200	13.8	1987
7766	5	23	220	18.3	1987
7766	5	24	137	8.1	1987
7766	5	25	115	6.2	1987
7766	5	26	139	8.6	1987
7766	5	27	89	4.4	1987
7766	5	28	78	0	1987
7766	5	29	78	1.9	1987
7766	5	30	90	2.7	1987
7766	5	31	158	13.2	1987
7766	6	1	192	8.4	1987
7766	6	2	189	14.9	1987
7766	6	3	88	3.7	1987
7766	6	4	-	11.3	1987
7766	6	6	137	13.0	1987
7766	6	7	112	4.2	1987
7766	6	8	184	16.8	1987
7766	6	9	218	20.3	1987
7766	6	10	190	5.9	1987
7766	6	11	195	4.5	1987
7766	6	12	88	2.3	1987
7766	6	13	52	0	1987
7766	6	14	-	0	1987
7766	6	16	115	0	1987

Cow #	month	day	activity	km	year
7766	6	17	100	0	1987
7766	6	18	102	3.8	1987
7766	6	19	106	0	1987
7767	5	20	24	0.7	1987
7767	5	21	30	3.8	1987
7767	5	22	78	3.9	1987
7767	5	23	123	10.0	1987
7767	5	24	60	2.7	1987
7767	5	25	26	1.3	1987
7767	5	26	55	6.7	1987
7767	5	27	44	2.0	1987
7767	5	28	86	0	1987
7767	5	29	27	0.7	1987
7767	5	30	55	2.0	1987
7767	6	1	118	9.1	1987
7767	6	2	56	0.7	1987
7767	6	3	-	14.6	1987
7767	6	6	-	3.9	1987
7767	6	7	-	32.0	1987
7767	6	9	254	22.9	1987
7767	6	10	318	27.1	1987
7767	6	11	271	18.9	1987
7767	6	12	167	13.7	1987
7767	6	13	133	9.7	1987
7767	6	14	106	6.9	1987
7767	6	15	156	13.0	1987
7767	6	16	156	6.7	1987
7767	6	17	52	0.6	1987
7767	6	18	49	0.6	1987
7767	6	19	55	5.7	1987
7767	6	20	42	0	1987
7767	5	20	36	3.9	1988
7767	5	21	63	5.7	1988
7767	5	22	25	3.3	1988
7767	5	24	23	1.3	1988
7767	5	25	38	2.0	1988
7767	5	26	74	9.3	1988
7767	5	27	7	2.0	1988
7767	5	28	14	2.0	1988
7767	5	29	47	2.3	1988
7767	5	30	141	13.0	1988
7767	5	31	43	3.8	1988
7767	6	1	54	10.4	1988
7767	6	2	126	23.9	1988

Cow #	month	day	activity	km	year
7767	6	3	46	9.8	1988
7767	6	4	65	22.1	1988
7767	6	5	108	19.4	1988
7767	6	6	52	15.3	1988
7767	6	7	51	12.8	1988
7767	6	8	26	1.9	1988
7767	6	9	49	12.8	1988
7767	6	10	24	6.7	1988
7767	6	11	75	21.4	1988
7767	6	12	53	5.9	1988
7767	6	13	9	0.6	1988
7767	6	14	-	3.1	1988
7767	6	16	17	1.3	1988
7767	6	17	23	3.1	1988
7767	6	18	20	5.7	1988
7767	6	19	25	3.9	1988
7767	6	20	12	0	1988
7767	5	20	21	3.8	1989
7767	5	21	10	2.0	1989
7767	5	22	11	2.3	1989
7767	5	23	17	0.7	1989
7767	5	24	9	0.7	1989
7767	5	25	14	1.3	1989
7767	5	26	13	1.9	1989
7767	5	27	22	5.6	1989
7767	5	28	13	5.6	1989
7767	5	29	14	8.1	1989
7767	5	30	14	3.7	1989
7767	5	31	12	3.2	1989
7767	6	1	10	4.6	1989
7767	6	2	10	4.9	1989
7767	6	3	13	5.7	1989
7767	6	4	20	9.3	1989
7767	6	5	29	22.9	1989
7767	6	6	16	9.3	1989
7767	6	7	18	20.9	1989
7767	6	8	25	18.9	1989
7767	6	9	-	0	1989
7768	5	20	13	0.6	1987
7768	5	21	9	1.3	1987
7768	5	22	23	2.7	1987
7768	5	23	26	4.9	1987
7768	5	24	22	0.6	1987
7768	5	25	18	4.2	1987

Cow #	month	day	activity	km	year
7768	5	26	27	4.9	1987
7768	5	27	31	7.5	1987
7768	5	28	-	2.0	1987
7768	5	29	25	0.6	1987
7768	5	30	-	3.2	1987
7768	6	1	53	7.5	1987
7768	6	2	31	3.2	1987
7768	6	3	21	1.3	1987
7768	6	4	-	6.1	1987
7768	6	6	38	2.7	1987
7768	6	7	22	2.7	1987
7768	6	8	83	14.8	1987
7768	6	9	108	14.7	1987
7768	6	10	138	14.4	1987
7768	6	11	177	6.9	1987
7768	6	12	66	12.5	1987
7768	6	13	74	11.7	1987
7768	6	14	187	22.6	1987
7768	6	15	117	14.9	1987
7768	6	16	97	10.0	1987
7768	6	17	36	2.2	1987
7768	6	18	65	6.3	1987
7768	6	20	38	0	1987
7769	5	20	96	2.5	1987
7769	5	21	49	5.1	1987
7769	5	22	137	11.0	1987
7769	5	23	95	4.9	1987
7769	5	24	55	3.7	1987
7769	5	25	107	5.8	1987
7769	5	26	72	4.8	1987
7769	5	27	132	7.0	1987
7769	5	28	71	2.0	1987
7769	5	29	86	4.2	1987
7769	5	30	-	7.2	1987
7769	6	1	249	18.8	1987
7769	6	2	99	8.4	1987
7769	6	3	63	1.9	1987
7769	6	4	-	24.2	1987
7769	6	6	67	6.4	1987
7769	6	7	106	5.9	1987
7769	6	8	128	7.6	1987
7769	6	9	61	1.9	1987
7769	6	10	69	2.0	1987
7769	6	11	196	1.2	1987

Cow #	month	day	activity	km	year
7769	6	12	126	7.4	1987
7769	6	13	48	6.4	1987
7769	6	14	89	3.7	1987
7769	6	15	113	9.3	1987
7769	6	16	224	20.7	1987
7769	6	17	99	3.9	1987
7769	6	18	113	7.4	1987
7769	6	19	91	5.4	1987
7769	6	20	108	0	1987
7769	5	20	30	1.3	1988
7769	5	21	47	9.0	1988
7769	5	23	49	6.8	1988
7769	5	24	181	14.2	1988
7769	5	26	71	5.7	1988
7769	5	27	66	5.7	1988
7769	5	28	70	6.3	1988
7769	5	29	36	2.0	1988
7769	5	30	67	1.9	1988
7769	5	31	112	4.2	1988
7769	6	1	50	3.7	1988
7769	6	2	145	12.4	1988
7769	6	3	88	4.9	1988
7769	6	4	62	6.7	1988
7769	6	5	73	9.8	1988
7769	6	6	90	4.2	1988
7769	6	7	227	19.1	1988
7769	6	8	95	2.0	1988
7769	6	9	23	13.0	1988
7769	6	12	54	5.9	1988
7769	6	13	75	9.6	1988
7769	6	14	-	18.2	1988
7769	6	16	118	6.6	1988
7769	6	17	13	1.8	1988
7769	6	18	153	18.8	1988
7769	6	20	38	0	1988
7769	5	20	46	3.9	1989
7769	5	21	16	4.5	1989
7769	5	22	27	2.7	1989
7769	5	23	44	1.3	1989
7769	5	24	21	4.3	1989
7769	5	25	13	0	1989
7769	5	26	21	2.3	1989
7769	5	27	32	1.9	1989
7769	5	28	18	5.3	1989

Cow #	month	day	activity	km	year
7769	5	29	73	6.0	1989
7769	5	30	91	9.7	1989
7769	5	31	64	9.1	1989
7769	6	1	44	0	1989
7771	5	23	-	3.7	1988
7771	5	28	90	2.6	1988
7771	5	29	140	4.3	1988
7771	5	30	153	14.5	1988
7771	5	31	147	3.7	1988
7771	6	1	277	20.6	1988
7771	6	2	265	25.1	1988
7771	6	3	183	10.0	1988
7771	6	4	196	14.9	1988
7771	6	5	309	15.0	1988
7771	6	6	295	8.4	1988
7771	6	7	76	3.8	1988
7771	6	8	90	1.3	1988
7771	6	9	96	0.6	1988
7771	6	10	96	1.9	1988
7771	6	11	102	2.2	1988
7771	6	12	106	2.5	1988
7771	6	13	108	1.9	1988
7771	6	14	-	0	1988
7771	6	16	128	3.8	1988
7771	6	17	98	3.7	1988
7771	6	18	124	2.2	1988
7771	6	19	123	3.8	1988
7771	6	20	150	0	1988
7771	5	20	53	2.6	1989
7771	5	21	95	2.3	1989
7771	5	22	200	6.8	1989
7771	5	23	128	3.9	1989
7771	5	24	60	0.6	1989
7771	5	25	88	4.5	1989
7771	5	26	147	12.5	1989
7771	5	27	234	19	1989
7771	5	28	184	12.7	1989
7771	5	29	135	13.2	1989
7771	5	30	146	6.8	1989
7771	5	31	137	5.7	1989
7771	6	1	130	9.1	1989
7771	6	2	144	12.4	1989
7771	6	3	155	6.7	1989
7771	6	4	110	5.1	1989

Cow #	month	day	activity	km	year
7771	6	5	259	20.6	1989
7771	6	6	260	15.5	1989
7771	6	7	187	8.4	1989
7771	6	8	211	17.3	1989
7771	6	9	176	4.4	1989
7771	6	10	93	2.2	1989
7771	6	11	89	2.2	1989
7771	6	12	76	1.3	1989
7771	6	13	98	1.9	1989
7771	6	14	132	3.1	1989
7771	6	15	101	2.5	1989
7771	6	16	114	5.9	1989
7771	6	17	132	1.3	1989
7771	6	18	117	5.4	1989
7771	6	19	113	2.0	1989
7771	6	20	149	0	1989
17760	5	20	26	5.5	1988
17760	5	21	40	1.2	1988
17760	5	22	22	1.2	1988
17760	5	23	32	0	1988
17760	5	25	54	3.9	1988
17760	5	26	32	2.2	1988
17760	5	27	71	7.8	1988
17760	5	28	68	13.1	1988
17760	5	29	46	7.8	1988
17760	5	30	48	3.9	1988
17760	5	31	38	0.6	1988
17760	6	1	31	5.6	1988
17760	6	2	35	1.9	1988
17760	6	3	42	2.5	1988
17760	6	4	81	27.9	1988
17760	6	7	48	7.4	1988
17760	6	8	44	11.8	1988
17760	6	9	45	8.9	1988
17760	6	10	93	24.3	1988
17760	6	11	85	14.5	1988
17760	6	12	51	9.9	1988
17760	6	13	79	20.3	1988
17760	6	14	-	8.3	1988
17760	6	15	76	11.2	1988
17760	6	16	63	8.2	1988
17760	6	17	51	2.7	1988
17760	6	18	13	0	1988
17760	6	19	17	3.2	1988

Cow #	month	day	activity	km	year
17760	6	20	8	0	1988
17762	5	20	46	3.2	1988
17762	5	21	45	2.0	1988
17762	5	22	58	0	1988
17762	5	23	33	1.9	1988
17762	5	24	61	3.3	1988
17762	5	25	67	4.3	1988
17762	5	26	64	3.2	1988
17762	5	27	46	2.7	1988
17762	5	28	94	5.6	1988
17762	5	29	130	11.6	1988
17762	5	30	65	7.4	1988
17762	5	31	-	11.8	1988
17762	6	2	106	2.0	1988
17762	6	3	51	0	1988
17762	6	4	51	4.9	1988
17762	6	7	77	4.9	1988
17762	6	8	103	3.8	1988
17762	6	9	85	5.8	1988
17762	6	10	157	7.7	1988
17762	6	11	122	7.7	1988
17762	6	12	158	4.9	1988
17762	6	13	84	0	1988
17762	6	14	-	4.5	1988
17762	6	16	125	13.0	1988
17762	6	17	98	5.5	1988
17762	6	18	106	3.3	1988
17762	6	19	124	2.3	1988
17762	6	20	159	0	1988
17768	5	20	66	4.6	1988
17768	5	21	44	3.3	1988
17768	5	22	66	6.5	1988
17768	5	23	56	5.6	1988
17768	5	24	52	3.3	1988
17768	5	25	73	3.3	1988
17768	5	26	63	3.3	1988
17768	5	27	68	1.3	1988
17768	5	28	37	5.0	1988
17768	5	29	71	1.3	1988
17768	5	30	74	0	1988
17768	5	31	153	26.1	1988
17768	6	2	243	17.3	1988
17768	6	3	90	8.7	1988
17768	6	4	197	32.8	1988

Cow #	month	day	activity	km	year
17768	6	5	254	25.9	1988
17768	6	6	297	24.4	1988
17768	6	7	51	1.3	1988
17768	6	8	63	2.2	1988
17768	6	9	48	4.2	1988
17768	6	11	64	2.2	1988
17768	6	12	32	0.6	1988
17768	6	13	67	0.6	1988
17768	6	14	-	14.6	1988
17768	6	16	125	5.8	1988
17768	6	17	102	7.9	1988
17768	6	18	146	13.2	1988
17768	6	19	133	8.5	1988
17768	6	20	136	0	1988
17768	5	20	77	2.7	1989
17768	5	21	53	6.9	1989
17768	5	22	-	3.9	1989
17768	5	23	210	13.5	1989
17768	5	24	114	1.9	1989
17768	5	25	172	10.6	1989
17768	5	26	189	11.8	1989
17768	5	27	93	10.6	1989
17768	5	28	67	5.6	1989
17768	5	29	59	6.0	1989
17768	5	30	69	2.0	1989
17768	5	31	114	3.2	1989
17768	6	1	-	0	1989

Appendix F. **Summary of distances moved during calving period, May 20-June 20, 1987 and 1988.**

Cow#	group	year	total km
	northwest		
7761	May 20-31	1987	92.8
7761	June 1-20	1987	35.7
7761	May 20-31	1988	90.8
7761	June 1-20	1988	43.3
7764	May 20-31	1988	115.0
7764	June 1-20	1988	82.9
7765	May 20-31	1987	61.2
7765	June 1-20	1987	81.9
7765	May 20-31	1988	35.0
7765	June 1-20	1988	109.6
17760	May 20-31	1988	47.2
17760	June 1-20	1988	168.6
	south-central		
7762	May 20-31	1987	16.5
7762	June 1-20	1987	89.5
7763	May 20-31	1987	24.4
7763	June 1-20	1987	69.2
7763	May 20-31	1988	18.8
7763	June 1-20	1988	89.2
7766	May 20-31	1987	77.2
7766	June 1-20	1987	109.1
7767	May 20-31	1987	33.8
7767	June 1-20	1987	186.1
7767	May 20-31	1988	48.6
7767	June 1-20	1988	180.1
7767	May 20-31	1989	38.9
7767	June 1-20	1989	96.5
7768	May 20-31	1987	32.5
7768	June 1-20	1987	154.5
7769	May 20-31	1987	58.2
7769	June 1-20	1987	142.5
7769	May 20-31	1988	57.1
7769	June 1-20	1988	136.7
7769	May 20-31	1989	51
17762	May 20-31	1988	57
17762	June 1-20	1988	70.3
17768	May 20-31	1988	63.6
17768	June 1-20	1988	170.2

Cow#	group	year	total km
17768	May 20-31	1989	78.7
	eastern cow		
7771	May 20-31	1988	28.8
7771	June 1-20	1988	121.7
7771	May 20-31	1989	90.6
7771	June 1-20	1989	127.3

Appendix G. **Caribou observations and transect areas for June 1987 and 1988 aerial survey on western and central Victoria Island, NWT.**

Transect No.	Area	On-transect		Transect	Area	On-transect	
1987 Date	km^2	Caribou	calves	No. Date	km^2	Caribou	calves
9 June 8	72	1	0	35 June 17	113	39	8
10	72	0	0	36	100	16	0
11	80	2	0	37	134	19	5
12	76	0	0	38	131	8	0
13	63	0	0	40	138	47	8
14	58	4	0	42	134	49	12
15	67	16	0	44 June 19	70	24	6
16	58	13	1	45	45	26	7
17	58	3	0	46	83	35	2
18	54	0	0	47	121	68	2
19 June 15	64	9	0	48	154	52	2
20	58	2	0				
21	56	6	0	totals		652	94
22	58	8	1				
23	81	5	1				
24	82	10	1				
25	96	20	2				
26	96	13	2				
27	92	15	5				
28	96	26	3				
29 June 16	96	28	0				
30	91	18	8				
31	92	23	9				
32	100	13	5				
33	100	17	2				
34	102	17	3				

Transect 1988 Date	Area km^2	On-transect Caribou	calves
1 June 12	115	1	0
2	109	5	1
3	144	2	2
4	141	6	2
5	146	6	1
6	136	23	9
7	140	7	2
8	143	21	6
9	147	6	0
10	160	19	3
11 June 13	236	41	15
12	196	19	9
13	192	66	20
14	184	47	2
15 June 14	192	33	9
16	198	73	21
17	198	47	16
18	154	32	9
19	211	39	10
20	179	51	4
21 June 15	186	80	23
22	224	72	12
23	224	42	7
24 June 16	211	40	9
25	154	27	0
Totals	4320	805	203

Appendix H. **Distances (km) between female caribou showing association during calving and rut, 1987 and 1988.**

1987

Cow#1 -	Cow#2	Jun.6	Jun.10	Jun.20	Oct.4	Oct.14	Oct.24
7761	7762	289.92	277.04	265.50	262.62	271.88	274.63
7761	7763	313.55	277.74	272.96	283.97	293.51	308.30
7761	**7765**	**74.76**	**71.50**	**58.89**	**77.50**	**81.83**	**86.11**
7761	7766	370.71	332.57	322.11	361.50	385.43	428.49
7761	7767	413.91	355.20	274.43	404.52	424.52	416.35
7761	7768	431.01	403.22	348.98	395.43	421.49	426.86
7761	7769	330.08	311.21	265.57	389.27	417.20	419.56
7762	**7763**	**60.25**	**48.20**	**11.34**	**58.95**	**57.48**	**51.27**
7762	7765	289.17	272.41	242.58	271.37	270.62	261.66
7762	7766	137.61	134.52	98.33	163.34	169.22	202.15
7762	7767	179.93	141.22	70.38	195.96	201.07	180.98
7762	7768	249.78	226.86	155.29	251.12	265.37	271.12
7762	7769	215.23	210.10	173.40	276.50	269.72	256.56
7763	7765	298.33	260.66	251.67	276.44	275.91	282.42
7763	7766	78.37	89.31	103.27	105.46	114.09	150.87
7763	7767	122.36	100.30	78.88	140.98	148.58	129.86
7763	7768	189.58	182.33	161.34	192.42	208.01	225.32
7763	7769	164.22	162.47	184.02	219.43	212.62	210.24
7765	7766	342.59	298.03	283.78	334.52	349.17	379.28
7765	7767	382.43	322.17	242.94	377.27	387.74	371.15
7765	7768	385.12	357.35	303.50	350.08	365.55	358.77
7765	7769	279.08	258.19	212.60	336.66	359.48	353.49
7766	**7767**	**45.59**	**24.76**	**42.98**	**43.12**	**39.11**	**24.41**
7766	7768	116.55	93.02	59.27	99.79	114.04	120.60
7766	7769	130.38	103.17	126.50	138.54	123.25	105.95
7767	7768	91.38	87.85	89.19	102.63	114.58	140.15
7767	7769	144.20	122.11	112.23	147.27	126.18	124.87
7768	7769	108.53	106.15	109.12	45.49	12.83	15.86

1988

Cow#1 - Cow#2		Jun.4	Jun.11	Jun.18	Oct.4	Oct.14	Oct.24
7761	7763	316.99	290.52	262.79	218.88	232.32	242.24
7761	**7764**	**54.11**	**37.11**	**38.31**	**49.71**	**37.53**	**33.57**
7761	**7765**	**73.34**	**72.68**	**59.87**	**68.37**	**61.65**	**63.35**
7761	7767	390.28	300.11	274.33	380.43	376.73	439.85
7761	7769	357.43	305.95	268.1	-	-	407.01
7761	7771	572. 0	575.63	573.12	584.99	574.26	576.45
7761	**17760**	**10.34**	**81.15**	**133.68**	**27.47**	**26.95**	**14.55**
7761	17762	299.74	307.54	312.45	-	292.22	303.82
7761	17768	423.76	359.15	382.02	-	418.98	435.14
7763	7764	301.07	277.99	245.28	229.83	231.62	230.46
7763	7765	282.06	283.19	239.99	193.14	203.30	205.79
7763	7767	99.09	75.56	87.93	186.18	170.44	217.82
7763	7769	161.31	167.04	188.46	-	-	234.71
7763	7771	422.81	433.7	463.37	474.11	462.55	445.72
7763	17760	320.74	355.3	369.57	240.91	255.29	254.25
7763	**17762**	**67.02**	**64.54**	**60.68**	**-**	**67.34**	**75.88**
7763	17768	168.16	160.46	211.68	-	243.05	243.23
7764	**7765**	**23.69**	**36.75**	**21.65**	**41.56**	**35.39**	**31.50**
7764	7767	363.88	278.90	246.39	373.26	363.51	418.84
7764	7769	318.8	276.12	231.84	-	-	379.93
7764	7771	522.01	539.13	535.07	552.04	543.47	544.85
7764	**17760**	**46.97**	**77.86**	**129.81**	**35.88**	**34.65**	**33.94**
7764	17762	295.40	302.50	298.93	-	295.31	296.94
7764	17768	389.43	331.96	348.31	-	398.86	409.71
7765	7767	342.02	274.14	233.92	331.73	329.07	388.61
7765	7769	295.21	259.28	212.76	-	-	348.43
7765	7771	499.65	512.05	514.04	517.67	511.19	514.80
7765	**17760**	**67.93**	**78.84**	**130.07**	**70.01**	**69.38**	**65.06**
7765	17762	280.14	314.74	295.70	-	268.70	275.15
7765	17768	366.1	318.52	331.15	-	363.47	378.34
7767	7769	108.67	93.98	107.79	-	-	113.33

Cow#1 - Cow#2		Jun.4	Jun.11	Jun.18	Oct.4	Oct.14	Oct.24
7767	7771	342.42	360.53	378.00	326.66	329.06	296.75
7767	17760	392.12	351.77	351.77	395.97	354.41	449.05
7767	17762	163.4	139.66	135.49	-	163.58	394.34
7767	**17768**	**75.44**	**87.81**	**131.42**	**-**	**88.84**	**78.19**
7769	7771	265.14	289.53	314.26	-	-	214.49
7769	17760	356.42	337.43	306.57	-	-	413.09
7769	17762	225.41	231.55	242.05	-	-	263.04
7769	**17768**	**79.31**	**64.95**	**125.79**	**-**	**-**	**43.36**
7771	17760	567.49	581.04	570.81	586.32	577.83	578.69
7771	17762	488.85	494.01	494.84	-	483.29	477.45
7771	17768	268.17	273.32	253.93	-	240.50	224.74
17760	17762	305.42	380.19	425.77	-	316.57	316.97
17760	17768	423.88	397.25	432.00	-	432.24	442.22
17762	17768	233.97	221.95	241.01	-	248.96	258.97

Appendix I. **Summary of the dates of radio-collared cows: their calving, necropsies and the histological effects of the collars.**

COW 7760 A

Collared March 1987, died May 1987 and fox-scavenged remains examined in June 1987. Femoral marrow was red-jelly; molar-teeth were heavily worn.

COW 7760 B

Collared March 1988, observed with calf in June 1988 and collected 14 May 1989, no calf and with second cow also collected. Both cows were pregnant; no visible fat reserves and depleted muscles; both had about 30-40 warbles each.
Gross necropsy: The collar was "one fist-loose" and had abraded a patch of broken hair 5x7 cm over the larynx area leaving stubble 2 - 10 mm long but no bare skin. There was a second small abraded patch at the base of the neck but no bare skin.
Histopathology: No lesions other than a slight thickening of epidermis.

COW 7762 A

Collared in March 1987, observed with a calf in June 1987 and died in February 1988. The collar was retrieved in March 1988 and the cow's intact carcass was examined. She was emaciated with red-jelly like femoral marrow fat; her teeth were heavily worn with lesions and bone swelling around the mandibular molars.

COW 7762 B

Collared in March 1988, calved in June 1988 (based on telemetry data) and collected in May 1989. The cow was thin and had heavily worn teeth and was pregnant.
Gross necropsy: The hair was broken and worn in patches at the juncture of the neck and shoulders; there was a small patch of stubble (2 mm thick) at the top of the neck posterior to the ears. Immediately posterior to the angle of the mandibles was a 10 x 20 cm patch of stubble (1 - 8 mm thick) with an area of 10 x 2 mm bare skin, which was thickened with some exudate on the surface.
Histopathology: Three samples were taken from area posterior to the mandibles and the response was mostly confined to breakage of hair shafts and mild hyperkeratosis. In some areas there was necrosis and ulceration of the dermis with marked dermal inflammation and surrounding acanthosis and dermal fibrosis.

COW 7763

Collared in March 1987, observed with a calf in June 1987, calved in June 1988 (based on telemetry data) and collected in May 1989. The cow was thin and had heavily worn teeth and was not pregnant.
Gross necropsy: The hair was broken and worn patchily along the back of the neck; there was a patch (10 x 10 cm) of stubble (1 - 2 mm thick) immediately posterior to the angle of the mandibles patch.

Histopathology. There were no gross lesions except for a lack of hair fibres and very short inactive follicles. There was mild hyperkeratosis (visible as fine flakes on the surface).

COW 7764 A

Collared in March 1987 and shot by a hunter in March 1987.

COW 7764 B

Collared in March 1988, calved in June 1988 and collected in May 1989. The cow was thin and had heavily worn teeth and was pregnant.
Gross necropsy: The hair was broken and worn patchily along the back of the neck; there was a small patch of stubble immediately posterior to the angle of the mandibles patch.

COW 7765

Collared in March 1987, observed with a calf in June 1987 and in June 1988 and collected in May 1989. The cow was thin and had heavily worn teeth and was not pregnant.
Gross necropsy: There was a patch of stubble immediately posterior to the angle of the mandibles and on the dorsal surface of the neck immediately anterior to the shoulders.

COW 7766

The cow was collared in March 1987 and was observed with a calf in June 1987 but the PTT failed in December 1987. Searches for the VHF transmitter failed in March 1988 but succeeded in June 1989 when the scattered remains of the cow were found.

COW 7767

Collared in March 1987, observed with a calf in June 1987 and in June 1988 and collected in May 1989. The cow was thin and had heavily worn teeth and was pregnant.
Gross necropsy: There was a small patch of stubble (5 mm thick) immediately posterior to the angle of the mandibles and on the dorsal surface of the neck immediately anterior to the shoulders.
Histopathology: The hair follicles were shallow and inactive in appearance. There was a mild collection of excess keratin on the surface with mild accumulation of lymphocytes and eosinophils in the superficial dermis with some fibrosis and hyperpigmentation.

COW 7768 A

The cow was collared in March 1987, observed with a calf in June 1987 and died in February 1988. The collar was retrieved in March 1988 and the cow's intact carcass was examined. She was emaciated with red-jelly like femoral marrow fat; her teeth were heavily worn.

COW* 7768 *B

The cow was collared in March 1988, calved in June 1988 (surmised from telemetry data) and was collected in June 1989. She was thin, had heavily worn teeth and was not pregnant.

Gross pathology: The collar had worn a patch of stubble about 10 x 12 cm with a small patch of bare skin immediately posterior to the ears and cut into the skin for a length of about 2 mm to a depth of about 0.5 mm. Under the chin was a patch of stubble (10 x 15 cm) but no exposed skin.

Histopathology: Most of the skin submitted was relatively normal. In some areas, the epidermis was slightly thickened with prolonged rete pegs. There was mild excessive keratin on the surface and in few foci this was mixed with neutrophilic debris. A few nodules of chronic inflammation were present in the dermis.

COW 7769

The cow was collared in March 1987, observed with a calf in June 1987 and was collected in June 1989. She was emaciated, her teeth were heavily worn and she was not pregnant.

Gross pathology: Immediately posterior to the ears and below the chin were patches of hair worn to a stubble but with no skin exposed

Cow 7771

Collared Collected 19 August 1990

Cow was with 5 cows, two calves including her calf which was also shot.

The cow had 2.8 cm backfat and her female calf had 1.8 cm back fat. The cow's skin and skull were taken as samples as well as liver and kidney tissue for DNA analysis.

Appendix J. **Caribou carcasses examined August 1988, southeast Victoria Island**

	Carcass	Skeleton	Sex	Age	Femur	Scavenged	Comments
1	Intact		Unk.	Yearling	Unk.	Partial, fox	Curled up
2	Intact		Bull	Prime	Empty	Partial, fox	Curled up, antlerless
3		Scattered	Unk.	Unk.	White fat	Yes	Possible wastage
4		Scattered	Unk.	Unk.	White fat	Yes	Possible wastage
5		Scattered	Unk.	Unk.	White fat	Yes	Within 25 m of 3 and 4
6		Dissarticulated	Bull	Prime	Empty	Yes	Antlerless
7		Scattered	Bull	Prime	Empty	Yes	Anterless
8		Intact	Cow	Old	Empty	Yes	Antlered, lying on side
9		Scattered	Unk.	Unk.	White	Yes	Possible wastage
10		Intact	Bull	Unk.	Red thread	Yes	Curled up, Antlerless
11		Intact	Bull	Unk.	Unk.	Yes	Curled up, Antlerless
12		Dissarticulated	Bull	Unk.	Empty	Yes	12, 13 and 14 all in small river valley
13		Dissarticulated	Bull	Unk.	Unk	No	antlerless
14		Intact	Bull	Young	Unk	No	antlerless
15		Intact	Cow	Old	Empty	Yes	antlered, worn teeth
16		Dissarticulated	Bull	4 year	Unk	Yes	Trap, stakes - bait
17		Intact	Unk.	Calf	Empty	No	3 cm spikes
18		Intact	Bull	Unk.	Empty	Yes	-
19	Intact		Unk.	Calf	Empty	Yes	Lying side, 3 cm spikes
20		Intact	Unk.	Calf	Empty	Yes	Lying side, 4 cm spike
21		Dissarticulated	Cow	Adult	Empty	Yes	No wear teeth,
22		Intact	Unk.	Calf	Empty	No	Lying on side
23		Dissarticulated	Unk.	Calf	Empty	Yes	
24		Dissarticulated	Unk.	Calf	Empty	Yes	
25		Dissarticulated	Unk.	Calf	Empty	Yes	
26		Intact	Cow	2-year	Empty	Unk.	
27		Intact	Cow	2-year	Empty	Unk.	
28		Intact	Cow	Adult	Empty	Unk.	